Impact of a theory-based intervention to prevent central line-associated bloodstream infections in a medical intensive care unit

a before-and-after study

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IMPACT OF A THEORY-BASED INTERVENTION TO PREVENT CENTRAL LINE-ASSOCIATED BLOODSTREAM INFECTIONS IN A MEDICAL INTENSIVE CARE UNIT: A BEFORE-AND-AFTER STUDY

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Abstract

The incidence of Central Line-Associated Bloodstream Infections (CLABSIs) in Greek ICUs is higher than many other countries and occurs within the uncertain context of an eight-year financial crisis. Previous international research has extensively demonstrated that CLABSIs are largely preventable, but the complexity of the context in Greek ICUs means that it is not clear how this problem should be addressed. This study examined the effectiveness of a multifaceted, theory-based intervention on CLABSIs rates, adherence to CLABSI evidence-based preventive practices, behavioural determinants and contextual influences.

An uncontrolled before-and-after study was conducted in one medical ICU in Athens, Greece. The study was informed by the Theory of Reasoned Action and self-efficacy and used survey questionnaires and non-participant observation (structured observation and field work). Specifically, the study examined at baseline CLABSIs and adherence rates, behavioural determinants (self-efficacy, behavioural intention, attitude, subjective norm and behavioural beliefs) of critical care physicians and nurses and contextual influences (culture, leadership and evaluation of practices).

A multi-faceted theory-based intervention was implemented and evaluated for its impact on infection rates, behavioural determinants and contextual factors. The six-month intervention involved environmental changes to aid implementation of practices, education, improvement of skills, evaluation of CLABSI preventive practices, feedback, changes to policies to improve teamwork and leadership, persuasive communication and reminders.

Findings indicated the intervention did not significantly reduce CLABSIs rates. However, adherence to central venous catheter handling will lead to mostly positive outcomes. Behavioural intention to adhere to CLABSI preventive practice was strengthened after the intervention. The intervention also resulted in changes in the ICU's culture, changes in policies to improve teamwork and communication, improvements in leadership for nurses with provision of positive feedback and rewarding by medical and nurse directors. A comprehensive education package, part of the intervention, was shown to be effective in increasing the knowledge of physicians and nurses.

In the era of CLABSI prevention through quality improvement initiatives, this study contributes to implementation science field by clarifying which actions and activities have the greatest likelihood of consistent success, and provides evidence that CLABSI prevention, whilst not easy, is feasible within a resource-constrained context.

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Abbreviations

HCAIs - Healthcare- associated infections

CLABSI - Central Line-Associated BloodStream Infections

ICU - Intensive Care Unit

HCWs - Health Care Workers

MDROs - Multi-drug resistant organisms

BSIs - BloodStream Infections

CVC -Central Venous Catheter

CR-BSI - Catheter-related bloodstream infections

CDC - Center for Disease Control and Prevention

INCC - International Infection Control Consortium

HCDCP -Hellenic Center of Disease Control and Prevention

ECDCP -European Center for Disease Control and Prevention

OECD - Organisation for Economic Co-Operation and Development

QI - Quality improvement

RCT -Randomised Control Trial

CUSP - Comprehensive Unit-Based Safety Programm

Chapter 1: Introduction

Healthcare-associated infections (HCAIs) are recognised as the most common complications for hospitalised patients and among the top 10 causes of death in the United States (Zingg et al. 2015). Central Line-Associated BloodStream Infection (CLABSI) is a prevalent infection within the critically ill population, representing 10-20% of all HCAIs, and its prevention has long had a prominent role in infection control practices (Miller & Maragakis 2012, Bianco et al. 2013). Although largely preventable, CLABSIs are still associated with increased morbidity, risk of death, length and cost of hospitalisation (Burke 2003, The Joint Commission 2012). Recent studies have shown that quality improvement initiatives can reduce CLABSI rates; however, clinicians struggle to adhere with evidence-based preventive practices, and some organisations respond better than others to infection control and prevention strategies (Krein et al. 2010, Blot et al. 2014, Zingg et al. 2015). Changing clinical behaviour is a challenging task, and hence it is necessary to better understand the behavioural influences that affect the implementation of CLABSI preventive measures (Young et al. 2006). Moreover, it has been emphasised that implementation studies need to consider or measure the potential impact of the context, when implementing quality improvement efforts to facilitate changes in practice (McCormack et al. 2002, Krein et al. 2010).

This study has incorporated beliefs, attitudes and organisational context into the development, implementation and evaluation of an intervention to reduce CLABSI rates in a medical intensive care unit (ICU) in Greece. The intervention was based upon healthcare workers' (HCWs) behavioural determinants, and analysis of the contextual elements of the ICU setting. An uncontrolled before-and-after design was employed, using quantitative and qualitative methods. This chapter begins by positioning the study within the wider context of HCAIs. It then focuses on CLABSIs with regard to their definition, epidemiology, risk factors and pathogenesis (Section 1.2). Next, the notion of CLABSI preventability is examined. The current CLABSI preventive recommendations are presented, whilst the need to study related behavioural and contextual influences on CLABSI prevention is highlighted. The infection control and prevention context in Greece is then outlined (Section 1.3). The chapter concludes with an outline of the thesis (Section 1.4).

1.1 Healthcare-associated infections (HCAIs): the magnitude of the problem

HCAI is the term used to describe an infection acquired by patients during the course of receiving treatment for other conditions within a hospital or other healthcare facility (WHO 2011). HCAIs are considered a major threat to patient safety. They represent the fifth leading cause of death in acute care hospitals, leading to excess morbidity, prolonged hospitalisation and healthcare expenditures (Septimus et al. 2014). A point-prevalence survey of European hospitals (n=1000) revealed that 80,000 patients have at least one HCAI on any given day, with corresponding financial losses amounting to approximately €7 billion, including direct costs only (WHO 2011, ECDC 2013). HCAIs have also been an economic burden for the UK's National Health Service, with their cost estimated at £1 billion per annum (Head et al. 2014). In the USA, estimates among adult patients have shown that approximately 440,000 HCAIs occur annually, with a cost of $9.8 billion per annum (Zimlichman et al. 2013). In addition to the cost of extended hospitalisation, healthcare organisations in the USA and Europe are in the position of also needing to address the added cost of HCAI-related legal claims pursued by patients' groups (Goldenberg et al. 2012). Since these lawsuits are widely reported, hospitals are inevitably censured with mistrust when attracting patients and funds, thus rendering them less competitive in the public sphere (Mindmetre research 2014). Furthermore, the emergence of multi-drug resistant organisms (MDROs) has also exacerbated the global clinical and economic burden of HCAIs, with at least two million people acquiring serious infections from organisms resistant to antimicrobial agents each year in the United States (CDC 2013).

Despite HCAIs being represented as an unavoidable adverse event for hospitalised patients, there is clear evidence that they are preventable (WHO 2011). Many studies have identified that nearly 70% of specific types of HCAIs (central line-associated bloodstream infections and catheter-associated urinary tract infections) can be prevented by using current evidence-based strategies (Umscheid et al. 2011). Infection prevention and control programmes have entered into a new era with more focus on prevention and improvement, which has led to infection prevention becoming central to many aspects of care. Since 2011 healthcare systems in the USA have promoted transparency through mandatory reporting, to public websites, of specific types of HCAIs (catheter-associated urinary tract infection, bloodstream infection and surgical site infection) (Septimus et al. 2014). The initiative of mandatory public reporting of HCAIs by hospitals was introduced as an incentive for them to improve their care, yet this has burdened them with financial penalties and increased accreditation requirements (Bryant et al. 2016). The abovementioned initiatives aimed to satisfy consumers' needs for safer care, and to bring HCAI prevention to the centre of the 'patient safety movement'; however, previous reviews did not clearly support the claimed benefits of mandatory reporting of HCAI rates (McKibben et al. 2006, Yokoe et al. 2008).

Surveillance of infection cases is a core and pivotal activity of any effective infection prevention and control programme, although it is seldom in place within national health systems (WHO 2011). Its purpose is to define the problem of HCAIs at national and international levels (through measurement, analysis and reporting), and to target prioritised strategies in order to reduce HCAIs (Bryant et al. 2016). Appropriate and reliable surveillance is a crucial and complex task, and its implementation involves many challenges affected by external forces (Karami 2016). These challenges focus mainly on the subjective elements of infection definitions and risk assessment issues. The infection control and prevention literature strongly supports the continuous use of standardised definitions of surveillance, based upon previously published criteria, in order for reliable data on infections to be confirmed (Yokoe et al. 2008). Within a surveillance programme, adjustment for patients' risk profiles is essential for meaningful comparisons between hospitals; however, little is known about how to adjust for the risk of HCAIs (Yokoe et al. 2008). Given that surveillance is an essential component of an infection control and prevention programme to improve patients' outcomes, investment in technology, time spent in data collection, and education of personnel is imperative for the collection, analysis and monitoring of accurate data (Gaynes 1997).

1.2 Defining central line-associated bloodstream infections

The majority of intravascular device-related bloodstream infections (BSIs) are related to central venous catheters (CVCs), often known as central lines. These are narrow tubes inserted into large veins, with the tip lying close to the heart. They are extremely prevalent in intensive care units (ICUs) with a mean utilisation rate ranging from 32% to 80% among adult ICU patients (Climo et al. 2003). CVCs are necessary for the infusion of medication, fluids or blood products, for hemodialysis, and for blood withdrawal or hemodynamic monitoring. Although CVCs are an integral part of modern practice, their use is associated with complications. BSIs are the most serious complication related to CVCs and the most frequent cause of HCAIs. Approximately 80 to 90% of all primary BSIs are catheter-related and most are due to CVC use (Climo et al. 2003; Safdar & Maki 2004). Two terms are used to describe infections due to the presence of a CVC. These are central line-associated bloodstream infection (CLABSI) and catheter-related bloodstream infection (CR-BSI). These terms are often used interchangeably, although their meanings differ (O'Grady et al. 2011). CR-BSI is a more rigorous clinical definition and requires specific laboratory testing (such as culturing the catheter tip) to identify the catheter as the source of the BSI. On account of these challenges a simpler definition is used for surveillance purposes. CLABSI is a surveillance definition used by the US Center for Disease Control and Prevention (CDC 2012) National Health Safety Network (NHSN). CDC-NHSN defines CLABSI as 'a laboratory-confirmed BSI in patients with a CVC 48 hour before infection onset, and not related to another site' (O'Grady et al. 2011). The term CLABSI is used throughout the present thesis.

The use of a standard CLABSI definition allows facilities to estimate the magnitude of this infection as well as to monitor trends and facilitate inter-hospital and intra-hospital comparisons (Braun et al. 2003, O'Grady et al. 2011). On occasions some BSIs are attributed to sources other than the CVC (e.g. pancreatitis) that may not easily be diagnosed, and hence the CLABSI surveillance definition may overestimate the true incidence of these infections (O'Grady et al. 2011, Marra et al. 2016). Unfortunately, such inflated CLABSI rates can damage hospitals' prestige and morale, given that CLABSI has been determined as a performance quality indicator in the US healthcare system (Sexton et al. 2010).

1.2.1 Risk factors for CLABSIs

Multiple risk factors have been reported for developing CLABSIs within the ICU population. These factors can be *intrinsic* (non-modifiable characteristics of the patient) or *extrinsic* (potentially modifiable, related to CVC insertion or maintenance factors) (The Joint Commission 2012, Perez 2012, Tabah et al. 2012). Table 1.1 presents these factors.

Table 1.1: Intrinsic and extrinsic risk factors for CLABSI.

Intrinsic risk factors	Extrinsic risk factors
Age; > 60years or <1-year Greater severity of illness Co-morbidities Gender; males greater risk than females	Prolonged hospitalisation prior to CVC insertion Microbial colonization at insertion site (heavy microbial colonisation at insertion site (femoral vein is more prone to develop CLABSI; internal jugular vein higher density of skin flora vs subclavian) Frequency of catheter manipulation Frequent use of invasive devices Duration of catheterisation Number of lumens Antibiotic use Parenteral nutrition Lack of experience of staff in the insertion and care of CVC

Adapted from *Preventing Central Line–Associated Bloodstream Infections: A Global Challenge, a Global Perspective* by The Joint Commission 2012, Oak Brook, IL: Joint Commission Resources.

1.2.2 Pathogenesis of CLABSIs

Understanding the pathogenesis of CLABSIs is essential for the development of targeted strategies to prevent such infections. Intravascular device-related BSIs are caused by two major sources: (a) microbial colonisation of the catheter, and (b) contamination of the fluid administered through the device, an infusate-related infection which rarely occurs (Maki et al. 2006). Microbial colonisation occurs when pathogens gain access to the extraluminal or intraluminal surface of the catheter where they can adhere to and become embedded in an extracellular matrix, named biofilm. Biofilm allows bacterial cells to survive microbial agents and the host immune system and to disseminate to other sites in the body through the hematogenous tract (Safdar & Maki 2004, O'Grady et al. 2011). Micro-organisms gain access to the catheters through:

- the insertion site into the percutaneous catheter tract at the time of insertion or in the following days, and along the surface of the catheter, colonising the tip of the catheter;
- direct contamination of the catheter's hub and lumens by contact with the hands of healthcare personnel;
- less commonly, pathogens are carried hematogenously from remote sources of local infection, for example pneumonia

(Goldmann & Pier 1993, Safdar & Maki 2004, O'Grady et al. 2011, Miller & Maragakis 2012).

A number of studies have identified cutaneous colonisation as a significant risk factor for CVC-related BSIs. Maki et al. (2006) employed molecular epidemiology to identify the pathogenesis of CLABSI. They identified that two-thirds of BSIs were derived from the insertion site; however, 26% of BSIs appeared to have been caused by intraluminal contaminants, suggesting that both routes are significant for CVCs. Other studies have found that the intraluminal route also begins to play a role when a CVC remains in place for longer than one to two weeks (Mahieu et al. 2001). Considering the pathogenesis of CLABSIs, it becomes apparent that multifaceted preventive strategies should focus on both routes (extraluminal and intraluminal) of CVC-related BSI. Prevention of colonisation at the insertion site (for example, skin antisepsis with chlorhexidine agent) reduces the occurrence of infections during the first ten days of the catheter's insertion. Prevention of contamination of the CVC lumen (for example, effective hand hygiene before handling of the catheter) minimises infections that can occur when catheters remain in place for longer periods of time.

The most common causative organisms responsible for BSI are gram-positive skin organisms including *coagulase-negative staphylococci*, *staphylococcus aureus* and *enterococcus* species (The Joint Commission 2012), followed by gram-negative organisms including *klebsiella* species and *escherchia coli*. However, the microbiology of BSIs in ICUs has changed during the last two decades due to the emergence of drug-resistant organisms (Tabah et al. 2012). Of particular importance among multidrug-resistant (MDR) bacteria is the presence of *acinetobacter baumannii* as a causative pathogen for BSIs in critically ill patients. It was identified that BSIs caused by the abovementioned pathogen occur more often in critically ill and frail institutionalised patients, who are exposed through invasive devices, for example central lines (Chopra et al. 2014).

In conclusion, all the aforementioned risk factors are important in the pathogenesis of CLABSI. Therefore, a comprehensive approach to CLABSI prevention is required, including broad practice changes and the implementation of multifaceted programmes to improve the use of best practices related to both the insertion and maintenance of CVCs.

1.2.3 Prevention of central line associated infections

Several studies and surveillance data reports have highlighted that CLABSI remains a global public health burden, in view of its impact on patients' morbidity, mortality, length of hospitalisation and on healthcare expenditures (The Joint Commission 2012, Mauger et al. 2014, Ista et al. 2016). The estimated cost per CLABSI case in the USA was about $45,000 (£28,000; €31,000) (Pronovost et al. 2010, Umscheid et al. 2011), while an additional increase in costs was reported due to the increase in the length of hospitalisation, which ranged from 7 to 21 days (Latif et al. 2015b). CLABSIs are the most significant HCAIs in the critically ill population, representing 10-20% of all HCAIs (Bianco et al. 2013). In 2009, 41,000 CLABSIs occurred in the USA, of which 18,000 were in ICUs (The Joint Commission 2012, Latif et al. 2015b). International Infection Control Consortium (INICC) data, from ICUs in 36 different countries throughout Latin America, Asia, Africa and Europe, revealed that, although the number of CL (central line) days were similar to those reported in the USA, CLABSI rates were higher outside the USA (4.63 as against 1.3) (Rosenthal et al. 2014). Overall rates in Europe seem, in general, to be consistently higher than those in the USA, although differences in the systems and definitions of surveillance of ICU-acquired infections make comparisons difficult.

Despite CLABSIs being extremely prevalent in the ICU population, various studies have reported that the actual number of CVCs outside ICUs exceeded those within the ICUs and that the majority of CLABSIs occur in non-ICU patients (Climo et al. 2003, The Joint Commission 2012, Marschall et al. 2014). In relation to mortality associated with CLABSI, although not all previous studies have reported excess mortality (Blot et al. 2005), a recent meta-analysis reported that CLABSI in the ICU population is associated with a significantly increased risk of death (Ziegler & Pellegrini 2015).

There has been significant progress in decades. The number of CLABSIs in ICU patients throughout the USA has dropped from an estimated 43,000 in 2001 to 18,000 in 2009 – a reduction of 58% (Miller & Maragakis 2012). A recent report by Wise et al. (2013) also revealed that, during the period 1990-2010, between

100,000 and 200,000 fewer CLABSIs occurred than would have been the case if rates had remained unchanged since 1990. This reduction represents 3,000 to 6,000 lives saved, and a cost saving of $414 million in ICUs, during 2009 alone (Centers for Medicare 2012). Moreover, some hospitals reported no CLABSIs in their ICUs for a sustained period of time (Pronovost et al. 2010). Although CLABSIs are preventable, a substantial number of studies have pointed out that more work is needed, not only in the effective implementation of evidence-based CLABSI preventive measures but also in the establishment of valid and consistent surveillance systems (Backman et al. 2010, Karami 2016). Indeed, considerable variance still exists in the systems used by ICUs to collect and analyse CLABSI data (Bion et al. 2012).

Prevention of CLABSI is based on guidelines (O'Grady et al. 2011), each of these recommendations having been categorised on the basis of existing scientific data, applicability and economic impact (Table 1.2). Although CLABSI evidence-based preventive practices are available (See, Appendix 1), researchers have pointed out that their adherence to CLABSI prevention is still suboptimal, and much variation in practice within and among hospitals still exists (Braun et al. 2003, Warren et al. 2006, Hocking & Pirret 2013).

In practice, effective implementation of research depends greatly on changing the behaviour of HCWs, which is a complex and challenging task (Whitby et al. 2007, Dixon-Woods et al. 2013). Identification and understanding of the behavioural determinants of HCWs (for example their attitudes and beliefs), that act as barriers to their adherence to infection control practices, is important for developing interventions which could potentially improve infection control practices (Whitby et al. 2007, De Wandel et al. 2010). It has been widely recognised that the use of a theory can provide a clearer explanation of clinical behaviour, by identifying factors that are amenable to change (Pittet et al. 2004, Grimshaw et al. 2004, Michie et al. 2008). Moreover, the development of behavioural change interventions based upon a theoretical approach rather than researchers' intuition is more likely to be effective, because the causative mechanisms of targeted actions can be explained (Cane 2012).

Table 1.2: Classification system of the level of evidence

Level	Descriptor
Category IA	Strongly recommended for implementation and strongly supported by well-designed experimental, clinical, or epidemiological studies.
Category IB	Strongly recommended for implementation and supported by some experimental, clinical, or epidemiological studies and a strong theoretical rationale; or an accepted practice (e.g. aseptic technique) supported by limited evidence.
Category IC	Required by state or federal regulations, rules, or standards.
Category II	Suggested for implementation and supported by suggestive clinical or epidemiological studies or a theoretical rationale.
Unresolved issue	Represents an unresolved issue for which evidence is insufficient or no consensus regarding efficacy exists.

Reprinted from *How to read a paper: The basics of evidence-based medicine* by Greenhalgh, T. 2014. UK: John Wiley & Sons.

Research indicates that the mixed effect and success of patient safety initiatives may be due to the different contexts in which the interventions are implemented, rather than the efficacy of the initiatives themselves (Steven & Shojania 2011, Ovretveit 2011, Kaplan et al. 2010). Variations in the implementation of evidence-based practices by HCWs within different clinical settings suggest the need to understand how different contexts influence performance, since what works in one setting may not work in another (Kringos et al. 2015). Context, in relation to quality improvement, has been defined as factors that potentially mediate the effect of the intervention (Kringos et al. 2015). Local culture, resources, training, motivation, teamwork, leadership and communication are some of the reported contextual elements that influence how infection control and prevention practices are implemented, even when similar implementation strategies are used (Krein et al. 2010). Understanding whether, or how much, context explains variation in performance would help intervention designers to make changes and improvements, and to disseminate them in similar settings (Ovretveit 2011).

It is well known that the mere existence of guidelines cannot ensure changes in clinical practice (Sax et al. 2013). Effective interventions, to achieve optimal adherence to infection control practices, are needed to reduce HCAIs and ultimately to improve patients' safety (Krein et al. 2010, Saint et al. 2013, Zingg et al. 2015). Researchers strongly support such interventions being based (a) on a theory enabling better understanding of the range of behavioural determinants affecting healthcare personnel when implementing infection control practices, and (b) on assessment of contextual factors that influence the implementation of evidence-based practices in healthcare settings (Krein et al. 2010, Dixon-Woods et al. 2011, Edwards et al. 2012).

1.3 The Greek context

The national policy context is significant in shaping organisational actions, and it is therefore important to understand the Greek national response to HCAI. The Greek Ministry of Health and the Hellenic Centre of Disease Control and Prevention

(HCDCP/KEELPNO) have a central infection control and prevention committee that is responsible for issuing national guidelines and coordinating the activities of the local hospital infection control teams. However, although legally enforceable rules exist relating to antimicrobial stewardship, there are neither similar regulations concerning the implementation of infection control nor national infection control guidelines. All hospitals (and ICU departments) are requested to develop institutional guidelines, based on infection control guidelines published by international bodies. However, the levels of adherence to these guidelines are not known, as there are no studies to either confirm or challenge adherence. National surveillance regarding nosocomial infections is not mandatory, however, in recent years the European Centre for Disease Control and Prevention (ECDCP) is making efforts to obtain data for HCAIs within Greek hospitals and ICUs. Because not all invitees respond to the request for data submission, this results in the data that ECDCP reports not being representative of the nationwide incidence of HCAIs in Greece. Therefore, no national benchmarking for HCAIs within Greek hospitals and ICUs exists.

Taking into consideration the data collection limitations, a point-prevalence survey undertaken by the ECDCP between 2011 and 2012 (ECDCP 2013), showed that 10% of hospitalised patients in Greece developed HAI, placing it among the European countries with the highest rate of HAI occurrence (Saripanidis 2016). BSIs were also reported at 18.9% in Greek hospitals – the highest among European countries (ECDCP 2013). Despite the lack of national benchmarking in HCAIs, previous point-prevalence studies have identified that CLABSI rates in Greek ICUs were 12.1/1000 catheter days (in 8 ICUs) and 11.8/1000 catheter days (in 3 ICUs) (Dima et al. 2007, Apostolopoulou et al. 2013 respectively). Data from a large point-prevalence study among 33 Greek ICUs revealed similar high CLABSI rates at 10.3/1000 catheter days (Papadomichelakis 2012). CLABSI rates in Greece are also much higher than the internationally reported rates, being at 4.63/1000 catheter days (Rosenthal et al. 2014), whereas even lower rates (1.3/1000 catheter days) have been reported from medical teaching ICUs in the USA (Dudeck et al. 2013).

The global financial crisis in 2008 might have contributed to increased CLABSI incidence in Greece. It is apparent that from 2010 onwards Greek hospitals and ICUs have been struggling to reduce the number of HCAIs. The total number of ICU beds has been reduced by 25% (from 578 to 438 beds) due to the lower number of nursing staff (Sotiropoulos 2017). Consequently, critically ill patients with several co-morbidities, despite an indication for ICU admission, are treated in the wards with multiple courses of extended-spectrum antibiotics, undergoing several invasive procedures and being treated by inexperienced nursing staff (Dimopoulos et al. 2015, Sotiropoulos et al. 2017). The risk of these patients, who are subsequently admitted to an ICU, acquiring an infection is high because they are extremely vulnerable and may experience significant co-morbidities and immunodeficiency. The risk of transmission of pathogens through a CVC is also increased, because the catheter is frequently inserted in emergency circumstances, or is accessed by personnel repeatedly each day, or is often in place for an extended period of time (Marschall et al. 2014). Additionally, the fact that Greece has the highest antibiotic consumption rates in Europe renders patients more prone to develop BSIs during their hospitalisation, and particularly on account of multidrug-resistant pathogens, giving rise to obvious challenges for effective antimicrobial treatment (Miyakis et al. 2011).

The strict implementation of national austerity measures has affected the number of nurses in Greek ICUs, the ICU nursing shortage having been previously documented as one of the most significant contributory factors for hospital infection outbreaks in Greek ICUs (Dima et al. 2007, Kousouli et al. 2018). Greece has always experienced a shortage of nurses, which has worsened during the recent period of economic crisis. According to a report by the Organisation for Economic Co-operation and Development (OECD 2013), Greece has the lowest number of nurses per 1000 population in Europe (Economou et al. 2014). A major study, covering 12 European countries, has also identified that Greece has the lowest nursing density (3.8 times lower than the highest nurse density of 14.8) and 47% of Greek nursing respondents in this European study, reported providing fair or poor quality of care (Aiken et al. 2012). During the crisis the hiring of new nurses has been frozen, while significant early retirement was observed as a result of reductions in gross salary and of pension scheme changes (Papathanasoglou & Mpoutzika 2012). Unemployment rates among nurses tripled from 8.6% in 2009 (Notara et al. 2010) to 27.8% in 2013 (Economou et al. 2014). Inevitably due to such nursing shortages, Greek nurses have suffered from high levels of burn-out and low levels of satisfaction with the quality of the care they provide –both factors which have been independently associated with crisis-related working conditions (Skefales et al. 2014). Additionally, lack of medical supplies was identified as a factor that has significantly exacerbated nurses' emotional exhaustion ($p<0.001$) (Rachiotis et al. 2014). This finding indicates that public hospital budget in Greece has affected the wellbeing of nursing personnel and thus, the quality of care provided to the patients.

Consequently, HCAI constitutes a significant and alarming problem for Greece. In an era of CLABSIs being preventable through implementation of various initiatives, including best practices, it is imperative to establish an understanding of the personal and contextual influences that contribute to the CLABSI problem in the Greek context. The reasons behind such high CLABSI rates in Greek ICUs may seem obvious; however, a more pragmatic and targeted approach to the problem is needed to turn CLABSI prevention in a more favourable direction. Therefore, this study will attempt, firstly, to establish baseline data regarding actual practices relating to CLABSI prevention within a medical ICU in Greece. Additionally, baseline contextual influences on the implementation of the abovementioned practices will be established. Thereafter, an intervention to assess the effect on CLABSI rates will be developed and evaluated.

1.4 Outline of the thesis

This thesis presents a study to evaluate the effectiveness of a theory-based intervention in reducing CLABSI rates within a Greek medical ICU. The intervention was designed based on theory and data collected at baseline and was implemented and evaluated during the study.

Chapter 2 sets the scene for the study and provides a systemic review of the evidence for the effectiveness of quality improvement (QI) interventions on CLABSI rates in an ICU setting. The study considers the rise of multifaceted QI interventions as a key approach to CLABSI prevention. It also considers the importance of context for the success of QI studies, thereby providing an overview of HCWs' adherence to evidence-based practices, along with characteristics of ICUs prior to the intervention. The study also examines the value of the QI strategies that have been implemented. Finally, the gap in knowledge identified from the review of the literature is presented.

Chapter 3 presents the theoretical basis for the study. It draws on the Theory of Reasoned Action and the self-efficacy construct and considers how the selected behavioural constructs can be used to understand the intention to perform a desired behaviour. It also presents the 'research design' required to meet the study's aims and objectives, in the light of the gap in knowledge identified in Chapter 2.

Chapter 4 sets out the study's aims and objectives, and examines the methods adopted for collecting data at the baseline period of the study (four months). The participants, research sites, development of the study's questionnaire, its refinement, translation and piloting, administration and response rates achieved, are all examined. Structured observation and field work during the baseline period are presented, and the steps taken to ensure ethical conduct of the study, along with access to the research sites, are also outlined. Data analysis procedures and issues of reliability and validity are critically discussed.

Chapters 5 presents the results from the baseline assessment. It provides an analysis of results related to the behavioural determinants of HCWs (who were employed in four ICUs) in their implementation of evidence-based CLABSI preventive measures. The characteristics of the participants are described. It also reports an analysis of the baseline findings in the intervention site and the characteristics of the HCWs at the intervention site are presented. Data about their knowledge of CLABSI prevention, alongside their perceptions of contextual elements related to culture, leadership and evaluation of practices, are presented. Adherence rates regarding insertion, handling and site care of a CVC are also reported. Analysis of findings from non-participant observation in the intervention site are presented, which reveal contextual barriers and facilitators relating to CLABSI prevention.

Chapter 6 describes the development of the intervention based upon the baseline findings; this intervention aimed to reduce CLABSI rates by addressing the behavioural determinants of CLABSI preventive measures. The steps that were followed to develop the components of the intervention are examined, and a rationale for their selection is presented.

Chapter 7 sets out the methods used to implement the study's six-month intervention. The aims and objectives of the intervention and the methods adopted for collecting data are presented. HCWs at the intervention site responded to the study's questionnaire and structured observation, to identify their adherence to procedures for insertion, handling and site care of a CVC, was also conducted. Methodological challenges, data analysis procedures and ethical considerations are examined. The tasks and the timeline for the intervention are presented. Evaluation of the effectiveness of the intervention on CLABSI rates and process measures is also presented. Changes in HCWs' knowledge, behavioural beliefs and perceptions of contextual elements after the implementation of the intervention are examined. Changes related to the actual implementation of the intervention are also presented.

Chapter 8 discusses the impact of the intervention on CLABSI and adherence rates in a Greek medical ICU. The key findings related to behavioural and contextual changes resulting from the implementation of the intervention are also examined. The strengths and limitations of the study are discussed. Finally, the conclusion of the study summarises the implications of its findings and recommends the direction for future research into CLABSI prevention. It also discusses the implications of the findings for medical policy and practice in Greece.

Chapter 2: Quality improvement interventions aimed at preventing CLABSI within an ICU: a review of the literature

2.1 Introduction

A large number of QI (quality improvement) studies have shown successful reduction of CLABSI rates in ICU settings; however, there is still significant variability in practice due to suboptimal adherence to evidence-based CLABSI preventive measures (Blot et al. 2014). There is also limited understanding as to how and why, of those successful QI interventions, some are more successful than others in reducing CLABSI rates. Moreover, it is not clear which components of the interventions are potential determinants for success. To address these problems this chapter examines QI interventions in relation to their baseline characteristics towards CLABSI prevention and to the QI strategies they used to change CLABSI preventive practices, that led to reduced CLABSI rates. The seminal work of Pronovost et al. (2006) was considered essential to be discussed at the beginning of this chapter, as this study was an exemplar study in CLABSI prevention and provided a solid background for CLABSI prevention research. A critical review of the research studies (1995 to June 2012 via a meta-analysis study published in 2014 and individual studies post July 2012) aiming to prevent CLABSIs through QI interventions is also presented. Following this, the QI interventions which were employed by the reviewed studies are examined. The chapter concludes by identifying a gap in knowledge and highlights the importance of the present study.

2.2. Review of Pronovost et al.'s (2006) seminal study

Pronovost and his colleagues (2006) implemented a large-scale study to evaluate the impact of a comprehensive unit-based safety programme (CUSP) on the safety climate within the statewide Michigan Keystone ICU project. They demonstrated that inexpensive interventions, known as bundles, could reduce CLABSI rates to a median of zero throughout 108 ICUs. Data were reported by 103 out of 108 ICUs in Michigan (USA). The mean rate of catheter-related BSI/1000 catheter days decreased from 7.7 at baseline to 1.4 during the follow-up period 16 to 18 months later ($p<0.002$). There was a significant decrease in incidence rate ratios (IRR) from 0.68 (95% confidence interval 0.53 to 0.88) at 0 – 3 months to 0.38 (95% confidence interval 0.26 to 0.56) at 16 – 18 months and 0.34 (95% confidence interval 0.24 to 0.48) at 34 – 36 months after the implementation of the intervention. The Keystone project continued to sustain low CLABSI rates for an additional 18 months after the first 18 months post- implementation (Pronovost et al. 2010).

The researchers developed an intervention which included five evidence-based measures related to CVC insertion, as recommended by CDC (Mermel et al. 2000). These measures were identified as having the greatest effect on CLABSI rates, and most importantly there were very few barriers to their implementation. The recommended practices were hand-washing before CVC insertion, use of maximum barrier precautions during CVC insertion (hat, mask, sterile gown, sterile gloves and full body sterile drape), skin antisepsis with chlorhexidine, avoidance of the femoral site if possible, daily review for CVC necessity, and prompt removal of unnecessary catheters. What distinguishes the Keystone project (Pronovost et al. 2006) is that researchers addressed both technical and adaptive problems. Technical problems are related to the available evidence, definition of measures, development of tools, checklists etc. Adaptive work concerns how these measures fit into the local context, taking into account personnel's beliefs, values or habits (Pronovost et al. 2008a).

Accordingly, the researchers developed, implemented and validated a Comprehensive Unit-Based Safety Programme (CUSP), intended to improve the culture of patient safety and to lead to measurable improvements in safety, for example lower CLABSI rates (Pronovost et al. 2005). Researchers realised very early that patient safety lies in changing the healthcare culture from blaming caregivers to improving treatment systems. The goals of the CUSP programme were to produce valid and rigorous data, ready to be disseminated, documenting improvements and engaging frontline staff. An eight-step process was developed, comprising:

- measurement of the patient safety culture through survey instruments
- education of staff regarding the science of safety
- identification of staff concerns about safety through the completion of three open-ended safety assessment questions
- adoption of an ICU by a senior executive who would meet with the staff on a monthly basis
- implementation of three improvement interventions
- documentation of the results
- sharing improvement efforts through a 'safety tales' form
- repeated measurement of the 'safety climate'.

It is apparent that human capital, involving either frontline staff or senior executives, has been engaged in every stage of this eight-step process. Pronovost et al. (2005, 2006) have highlighted that behind a consistent and sustained improvement in quality indicators (for example, low CLABSI rates) lies change in human behaviour.

Social, cultural, and environmental factors are among those that might have caused discrepancies in practice; however, these are rarely taken into account (Edwards et al. 2012). Pronovost et al. (2005, 2008b) appreciated the local context prior to any intervention implementation. They therefore measured the ICU staff's commitment to patient safety through a 10-item scale (Safety Climate Scale, Pronovost et al. 2003). Previous work has identified that senior executives need to become more visible to frontline staff while patient safety initiatives take place. Additionally, proactive strategic planning for patients is needed, while physicians need to be further educated on patient safety (Pronovost et al. 2003). Prior to implementation of any intervention addressing CLABSI prevention, the researchers identified local barriers by observing the CVC insertion process and by asking staff where any defect occurred (Pronovost et al. 2008c). One of the cornerstones of CUSP was the empowerment of frontline staff to take responsibility for patient safety issues. In a complex environment such as an ICU, issues of responsibility and accountability are central to the provision of 'do no harm' care within the working environment. In the light of the success of this large-scale project, it seems that the 108 ICUs participating in the Keystone project might already have had an established culture in which patients' individuality and integrity was protected (Belela-Anacleto & Pedreira, 2016).

Despite some reported limitations, Pronovost at al (2006) signified a new era in research into CLABSI prevention. Their study demonstrated for the first-time large-scale improvements in the culture of safety within diverse hospitals. Dixon-Woods et al. (2011) explained the success of the Keystone project, which was different from other large-scale studies in several important ways. Firstly, this programme included robust measurement of CLABSIs while it tracked performance. Secondly, evidence-based practices or 'bundles' were distinguished from the interventions to implement those practices; the project standardised the former and encouraged clinicians to modify the latter within their local context. Thirdly, the programme explicitly focused on improving local culture. Fourthly, the programme reframed CLABSI as a social problem that could be addressed by changes at a professional level. Thus, it was structured as an intervention that strengthened HCWs' identity and cohesiveness, was led by clinicians, and focused on social support to change behaviour. The Keystone programme, and particularly CUSP, was latter applied in other ICUs in the US (Hong et al. 2013, Berenholtz et al. 2014), in Europe, including the UK (Bion et al. 2012) and Spain (Palomar et al. 2013) and the Middle East (Latif et al. 2015a).

In the section that follows, the literature search strategy that started in November 2013 is presented. The aim of this literature search was to identify relevant studies after Pronovost et al's (2006) seminal work, what interventions were employed by the relevant studies and the evidence for their effectiveness in reducing CLABSI within the ICU setting.

2.3 Literature search

2.3.1 Formulating a search strategy

A systematic search of a number of sources was undertaken to retrieve as much potentially relevant literature as possible. A facet analysis was established using the acronym PICO (*Population, Intervention*, *Comparison to, Outcome*) (Schardt et al. 2007) in order to select the most valid and relevant studies related to CLABSI prevention using a quality improvement intervention (Table 2.1). The question was broken down into its facets defining the a) *Population:* adult critical care patients with a central line catheter; b) *Intervention:* multifaceted quality improvement initiatives; c) *Outcomes*: impact on CLABSI rates; d) *Study design*: quantitative studies. Different search tools such as truncations (*, $) and Boolean operators (OR and AND) were applied, to maximise the sensitivity and specificity of the search (Greenhalgh 2014).

Table 2.1: Facet analysis

Population			Intervention		Comparison	Outcome
Adult ICU patients with central line catheters			Quality improvement intervention		Baseline standard care	CLABSI rates
Adult ICU patients		Central line catheters				
Terms Searched		**Terms searched**	**Terms Searched**		**Terms Searched**	**Terms Searched**
adult intensive care unit (text word and MesH term)	**A**	**catheter$** (text word and MesH term)	**improv$ adj2 quality**	**A**	*Not specified in search*	**Nosocomial infection** (text word and MesH term)
OR	**N**	**OR**	**OR**	**N**		**OR**
adult critical care (text word and MesH term)	**D**	**Central venous** (text word and MesH term)	**prevent$ adj2 infection**	**D**		**Bacteremia** (text word and MesH term)

A search of the primary outcome was the number of CLABSIs per 1000 catheter days pre- and post-intervention. An initial scoping search was undertaken through the Google Scholar database, followed by a more structured systematic search using COCHRANE Library, Cumulative Index for Nursing and Allied Health Literature (CINAHL), Excerpta Medica database (EMBASE), MEDLINE databases (an example of the database search is included in Appendix 2). The Cochrane Library database was searched to identify any relevant systematic reviews. Research studies published between 2000 and 2013, including critically ill patients aged over 18 years, were identified within the abovementioned databases. The

Greek medical database Iatrotek (2002-2013) was also searched to locate any relevant studies undertaken within Greek ICUs. Subsequently, both titles and abstracts of papers identified in each database were screened to identify the eligible studies before reading the full text. Duplicate studies, conference articles, editorials and letters were removed. Manual searches were also conducted by scrutinising the references in relevant studies to identify any further relevant papers.

2.3.2 Inclusion and exclusion criteria

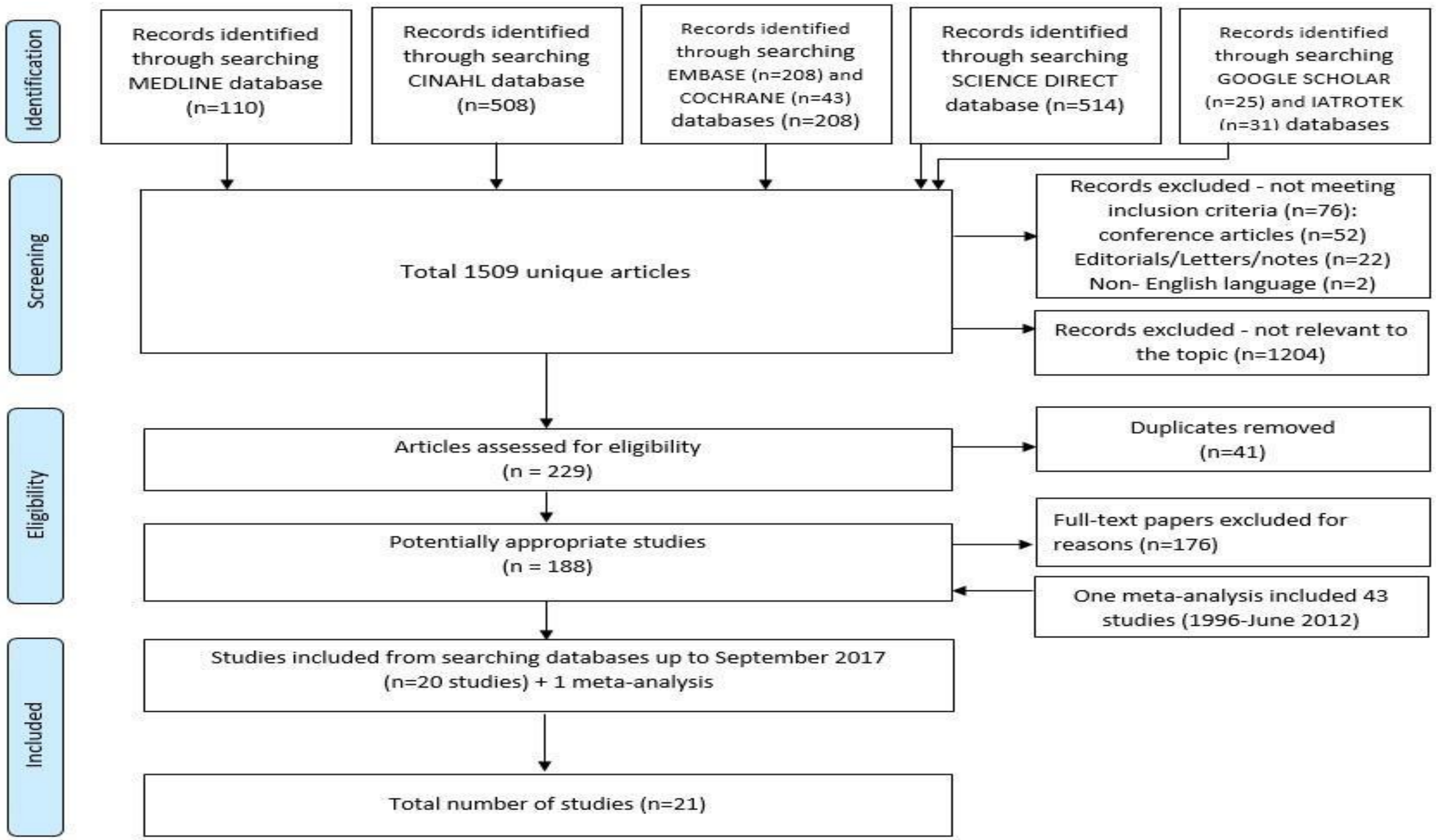
A set of criteria was established to select the most valid and relevant previous studies related to the present study's research topic (Table 2.2). The principal exclusion criterion was the relevance of the studies to the present research. Firstly, studies had to be conducted in an ICU setting among adult critically ill patients. The ICU setting has distinct characteristics, in terms of organisational structures, processes and patient risk factors, compared to those within general wards and among pediatric patients. Secondly, studies had to report that they implemented an intervention, and on the methods for collecting data regarding changes that occurred.

Table 2.2: Inclusion and exclusion criteria for literature search strategy

Inclusion criteria	Exclusion criteria
Studies reported clear research design and data collection procedure(s)	Studies that used single interventions
Studies reported data on CLABSI rates before and after the implementation of a QI intervention	No primary research: editorials, letters, viewpoints, commentaries
Studies undertaken among critical care adult patients (aged >18 years) hospitalised in ICU setting	Not relevant to literature review focus

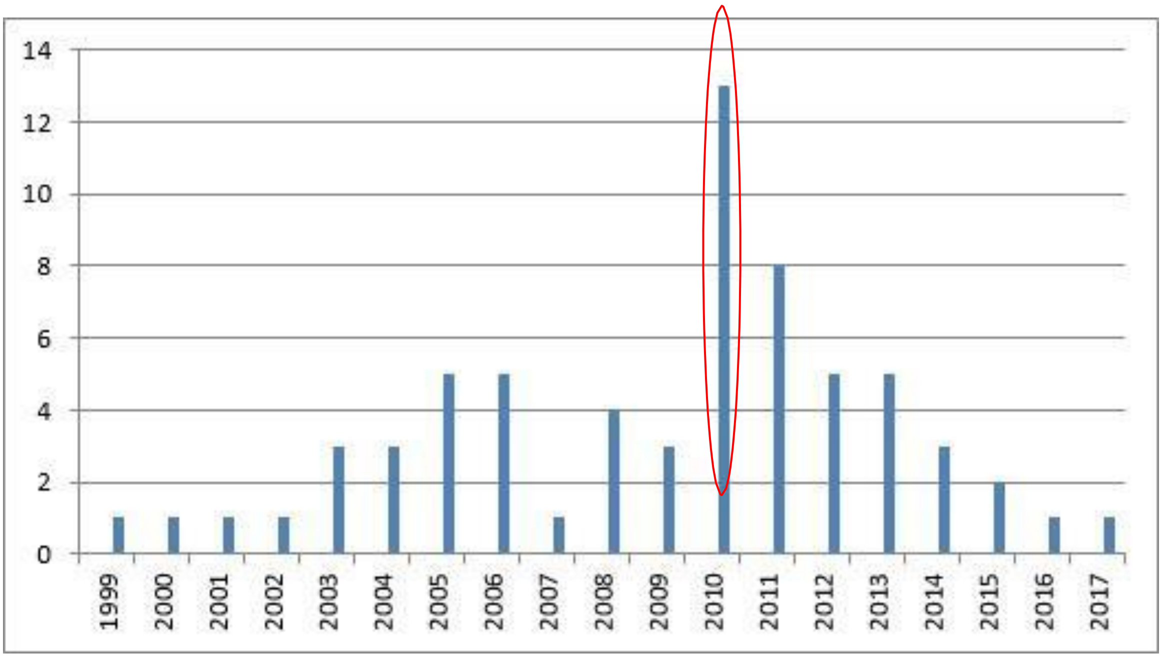
A systematic review and meta-analysis (Blot et al. 2014) were published (April 2014) during the screening of the identified studies. This meta-analysis included 43 relevant studies covering a period between January 1995 and June 2012. To avoid repetition, these 43 studies were removed from the search results, though their meta-analysis results have been included in the present literature review. Following this, eleven studies covering the period between July 2012 and November 2013 (when the searching of databases commenced) were eligible for inclusion. To ensure that the present review includes current research on the study's topic, continuous searches were undertaken within individual databases, were saved and re-run on a regular basis; thus, a further nine studies (published up until September 2017) were identified and included. Only studies published in English were included as no relevant studies were identified in the Greek medical database Iatrotek. A total of twenty-one studies (one meta-analysis and 20 QI relevant studies) were included in the present review. The selection process for the included studies is presented in Figure 2.1.

Figure 2.1: Literature identification process



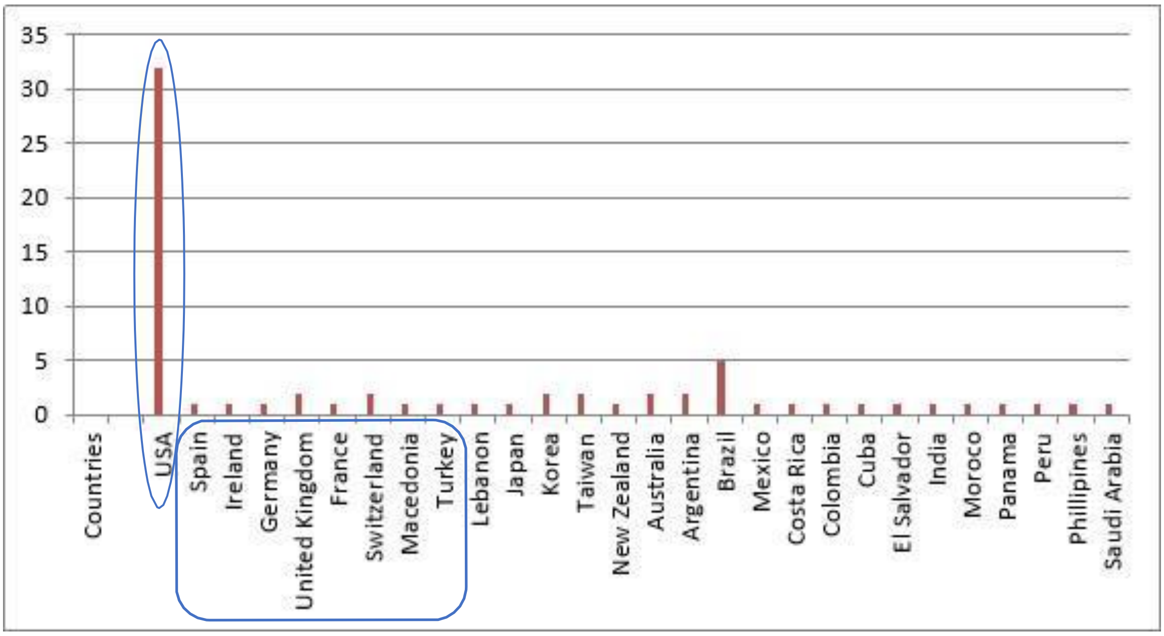
A notable observation from the research on CLABSI prevention post 1999 and onwards, is the acceleration in the rate of publications occurring in 2010 (Figure 2.2), highlighting the pressure exerted on hospitals to improve their quality of care, and the focus on redesigning the health care system to emphasise patient safety (Alexander & Herld 2011).

Figure 2.2: Number of QI studies published from 1996 to 2017



Furthermore, major advances in understanding the epidemiology and pathogenesis of CLABSIs have supported the evolution of QI interventions addressing CLABSI prevention (Rosenthal 2008). Predominantly, research was undertaken in the United States (USA) (Figure 2.3), while fewer studies were conducted in Europe. Research has also taken place in Australia, Asia, Africa, Latin American countries and in countries of the developing world.

Figure 2.3: QI studies: frequency per country from 1996 to 2017



2.4 Research studies assessing the effectiveness of QI interventions to prevent CLABSI in adult critically ill patients: a review of the literature

A total of twenty-one studies, including one meta-analysis (Blot et al. 2014), were selected for review in this chapter. Overall, the twenty QI interventions included more than one strategy (termed multifaceted). The multifaceted approach has been widely supported as a powerful method for changing behaviour, even though more effort and resources are required compared with a single strategy approach (Kurtis et al. 2006, Miller & Maragakis 2012). Nevertheless, a recent overview of 25 systematic reviews has provided no compelling evidence regarding the effectiveness of multifaceted interventions in comparison with single-component interventions (Squires et al. 2014). Although a significant number of QI studies have shown that CLABSI is preventable in an ICU setting (Ista et al. 2016), there is little understanding of the various contextual factors affecting individuals and organisations when effectively adopting CLABSI preventive practices. Details of the studies (n=21) included in the present review are presented in Table 2.3.

Table 2.3: Characteristics of the reviewed studies

	Author / Country / Setting	Study period and design	CLABSI preventive measures	Quality improvement intervention	Results: measurements of adherence with CLABSI preventive measures	Results: CLABSI rate per 1000 catheter days
1	**Blot et al. (2014): Meta-analysis of 43 studies published between 1996 to June 2012** **564 ICUs included in meta-analysis**	Duration of studies: 9 months-180 months 35 before-and –after studies 1 controlled before-and –after study 5 ITS studies	**Baseline:** N/A **Intervention**: N/A	14 types of interventions: Education (n=33), Training (n=4), Feedback (n=20), Clinical reminders (n=15), Bundle (n=11), Checklist (n=18), Empowerment to stop procedure (n=10), Audit of compliance (n=12), Leader designation (n=11), Infrastructure changes (n=2), Organisational changes (n=4)	18 studies reported adherence	Baseline: ranged from 2.1 to 46.3. 10 studies did not demonstrate reduction of CLABSI Before-and-after trials showed reduction in CLABSI rates: 0R, 0.39, 95% CI,.33-.46, p<.0001
2	**Lin et al. (2012), USA, 20 ICUs**	Baseline: Jan to June 2009 Intervention: July 2009 to Dec 2010 Pre- post intervention study	**Baseline:** N/A **Intervention:** Insertion bundle: Effective hand hygiene Full-barrier precautions Skin antisepsis with CHX Avoid femoral Daily review for CVC necessity	CUSP: Educate - Identify defects - Assign executive to adopt unit - Learn from one defect per quarter - Implement teamwork tools Leadership Immersion calls Coaching calls One-day face-to-face meetings Distribution of templates and tools	N/A	Baseline: 1.5 Intervention: 0.6 at 16 to 18 months post-intervention

	Author / Country / Setting	Study period and design	CLABSI preventive measures	Quality improvement intervention	Results: measurements of adherence with CLABSI preventive measures	Results: CLABSI rate per 1000 catheter days
3	**Marsteller et al. (2012), USA, 45 ICUs**	Baseline: 2006 Intervention: March 2007 - Dec 2008 Post-intervention: January 2008 - Sept 2008 Multicenter, phased, cluster-randomised controlled trial	**Baseline**: N/A **Intervention**: Insertion bundle: Effective hand hygiene Full-barrier precautions Skin antisepsis with CHX Avoid femoral Daily review for CVC necessity	Nurse observer with checklist to ensure adherence CUSP intervention: *Engagement* of staff to address the problem *Education* of staff on the evidence *Regular* process evaluation and outcomes *Expansion* of programme to other units *Planning* of ways for the intervention to endure as regular practice Development of dressing change checklist Feedback of infections Staff filled out Team Checkup Tool: monthly	N/A	Baseline: intervention vs control group: 4.48 vs 2.71 (p=0.28), respectively. Intervention: 1.33 vs 2.16 (p=0.003) Intervention group sustained <1/1000 rates at 19 months

	Author / Country / Setting	Study period and design	CLABSI preventive measures	Quality improvement intervention	Results: measurements of adherence with CLABSI preventive measures	Results: CLABSI rate per 1000 catheter days
4	**Bion et al. (2012), UK, 223 ICUs**	2- year study: April 2009 - March 2011 Cluster non-randomised trial	**Baseline**: N/A **Intervention:** Effective hand hygiene 2% CHX skin antisepsis Full-barrier precautions, before CVC insertion Avoidance of the femoral route Daily review and prompt removal CVC maintenance: aseptic access technique	Checklists: CVC insertion Two-day training session Web-based teaching Root cause analysis Staff safety assessment Team work and communication Daily goals checklists	N/A	Baseline: 3.7 Intervention: 1.48 ($p<0.0001$) (adult ICUs)

	Author / Country / Setting	Study period and design	CLABSI preventive measures	Quality improvement intervention	Results: measurements of adherence with CLABSI preventive measures	Results: CLABSI rate per 1000 catheter days
5	**Cherifi et al. (2013), Belgium, 5 ICUs**	Pre-intervention: March 2011 - August 2011 Intervention phase: Sept 2011 - Feb 2012 Post-intervention: March 2012 - Sept 2012 Quasi-experimental study	**Baseline:** Effective hand hygiene Full-barrier precautions Skin antisepsis (0.5% CHX in 70% alcohol or alcoholic povidone-iodine), before CVC insertion Replacement of gauze dressing every 24 hours or when damp, loose, or visibly soiled Replacement of transparent dressings every 7 days or when damp, loose, or visibly soiled Disinfection of catheter hubs before they are accessed with an appropriate antiseptic Documentation about CVC, dressing and lines **Intervention:** as baseline	Monitoring of 5 CVC care process Compliance rate with care process Monthly meeting with ICU staff to report outcome and process indicators Feedback: monthly	Compliance with: **HH** increased from 46% to 84% (p<0.001) **CVC handling** increased from 69% CVC to 81% (p<0.003) **CVC care** increased from 82% to 91% (p<0.001) **CVC insertion** 100% before-after	Baseline:4.0 Intervention:1.81 with IRR of 0.49 (p=0.043) Post-intervention: 2.73 in comparison to baseline

	Author / Country / Setting	Study period and design	CLABSI preventive measures	Quality improvement intervention	Results: measurements of compliance with CLABSI preventive measures	Results: CLABSI rate per 1000 catheter days
6	**Hong et al. (2013), USA, 17 ICUs**	Oct 2008 - March 2011 Pre- post intervention study Before-and-after study	**Baseline**: N/A **Intervention**: Effective hand hygiene Full-barrier precautions Skin antisepsis with CHX Avoid femoral Daily review for CVC necessity	CUSP: Educate - Identify defects - Assign executive to adopt unit - Learn from one defect per quarter - Implement teamwork tools Monthly coaching calls Daily goal implementation Staff safety assessment Site visits	N/A	Baseline: 1.8 Intervention: 1.1 at seven quarters post -intervention, 41% reduction (p=0.066)

	Author / Country / Setting	Study period and design	CLABSI preventive measures	Quality improvement intervention	Results: measurements of adherence with CLABSI preventive measures	Results: CLABSI rate per 1000 catheter days
7	**Jeong et al. (2013), Korea, 4 ICUs**	Baseline: April 2009 - March 2010 Intervention: April 2010 - Dec 2011 Pre- post intervention study	**Baseline:** Provision of antiseptic foam near the entrance of each ICU for hand disinfection **Intervention:** Effective hand hygiene Full-barrier precautions Skin antisepsis with CHX Avoid femoral	Systemic training on the CL bundle Creation of posters for the CL bundle Distribution of educational programmes and materials Active surveillance Feedback: weekly, monthly CVC insertion compliance through electronic checklist	**Baseline:** full compliance with CVC insertion bundle was 0.0% **Intervention**: full compliance with CVC insertion bundle significantly increased to 37.1% (p<0.001)	Baseline: 4.7 Intervention: 1.8 (p=0.076)

	Author / Country / Setting	Study period and design	CLABSI preventive measures	Quality improvement intervention	Results: measurements of adherence with CLABSI preventive measures	Results: CLABSI rate per 1000 catheter days
8	**Jaggi et al. (2013),** **India, 16 ICUs**	Baseline: 3 months Intervention: Sept 2004 - Feb 2012 Before -after study	**Baseline**: N/A **Intervention:** Hand hygiene before CL insertion or manipulation Use sterile gauze or a transparent sterile dressing to cover the insertion site Change the gauze every 48 h and the transparent dressing every 7 days Prompt removal of CVC Change the administration set every 96 hours; unless used for fat, nutrition, or blood precuts, and in these cases change every 24 hours Use CHX for skin antisepsis Preferably use the subclavian vein Use maximal sterile barrier precautions during CL insertion Disinfect line hubs, needleless connectors, and infection ports before accessing the CL	Bundle of infection control interventions Education Audit Feedback of CLABSI rates Feedback of performance with: HH - Date on administration set - Placed dressing - Correct condition of dressing Use an all-inclusive catheter cart or kit	Hand hygiene compliance 73% vs 84%, p=0.0001 Compliance with date on administration set 97% vs 96%, p=0.47 Compliance with placed dressing 99% vs 98%, p=0.313 Compliance with correct condition of dressing 94.9% vs 92%. p=0.1	Baseline: 6.4 Intervention: 3.9 IRR 0.61, 95% CI 0.5 - 0.8; p = 0.0007

	Author / Country / Setting	Study period and design	CLABSI preventive measures	Quality improvement intervention	Results: measurements of adherence with CLABSI preventive measures	Results: CLABSI rate per 1000 catheter days
9	**Khalid et al. (2013), Saudi Arabia, 1 MSICU**	Baseline: Feb 2009 - Jan 2010 Post intervention year 1: Aug 2010 - July 2011 Post intervention year 2: Aug 2011 - July 2012 Pre- post intervention study	**Baseline**: N/A **Intervention:** Insertion bundle: Effective hand hygiene Full-barrier precautions Skin antisepsis with CHX Avoid femoral Use of CVC coated internally with silver sulfadiazine and CHX acetate CHX wipes for patient cleaning 5-moments HH Maintenance bundle: Wearing gloves, before accessing CVC	Extensive education sessions Dedicated clinical nurse educator for night shifts Educational flyers Audits for compliance with central line bundles Daily reminders regarding CVC removal Feedback with CLABSI rates displayed monthly	**Baseline**: Compliance with CVC insertion bundle was 85% Compliance with CVC maintenance bundle was 75% **Intervention:** Compliance with CVC insertion bundle was 96% Y1 - 99% Y2 Compliance with CVC maintenance bundle was 91% Y1 - 97% Y2	Baseline: 6.9 Intervention:1.06 (year 1) ($p<0.001$) and to 0.35 (year 2) ($p<0.001$)

	Author / Country / Setting	Study period and design	CLABSI preventive measures	Quality improvement intervention	Results: measurements of compliance with CLABSI preventive measures	Results: CLABSI rate per 1000 catheter days
10	**Leblebicioglu et al. (2013), Turkey, 13 ICUs**	Baseline: 3 months Intervention: Sep 2003- Jan 2011 Before -after study	**Baseline**: N/A **Intervention:** Hand hygiene before CL insertion or manipulation Use sterile gauze or a transparent sterile dressing to cover the insertion site Change the gauze every 48 hours and the transparent dressing every 7 days Prompt removal of CVC Change the administration set every 96 hours; unless used for fat, nutrition, or blood precuts, and in these cases change every 24 hours Use CHX use for skin antisepsis Preferably use the subclavian vein Use maximal sterile barrier precautions during CL insertion Disinfect line hubs, needleless connectors, and infection ports before accessing the CL	Bundle of infection control interventions, Education, Audit Feedback of performance with: HH - Date on administration set - Placed dressing - Correct condition of dressing Feedback of CLABSI data Use an all-inclusive catheter cart or kit	Hand hygiene compliance 32% vs 49%, p=0.0001 Compliance with date on administration set 33% vs 96%, p=0.47 Compliance with placed dressing 99% vs 98%, p=0.313 Compliance with correct condition of dressing 94.9% vs 92%. p=0.1	Baseline: 22.7 Intervention: 12.0 [IRR=0.613; 95% CI 0.43 - 0.87; P 0.007]

	Author / Country / Setting	Study period and design	CLABSI preventive measures	Quality improvement intervention	Results: measurements of adherence with CLABSI preventive measures	Results: CLABSI rate per 1000 catheter days
11	**Palomar et al. (2013), Spain, 192 ICUs**	Baseline: April - Dec 2008; Intervention: Jan 2009 - June 2010 Prospective time series study	**Baseline**: N/A **Intervention:** Insertion bundle: Effective hand hygiene Full-barrier precautions Skin antisepsis with CHX Subclavian preferred insertion site Daily review for CVC necessity **Maintenance:** Reduction of the handling of the hubs Cleaning of the injection ports with isopropyl alcohol 70° before accessing the system	CUSP: Educate - Identify defects - Assign executive to adopt unit - Learn from one defect per quarter - Implement teamwork tools CVC insertion and maintenance bundle Coaching webinars Content calls Peer-to peer mentoring Patient safety workshops Site visits Web-based platform Feedback	N/A	Baseline: median 3.07 Intervention: 1.12 episodes ($p < 0.001$).

	Author / Country / Setting	Study period and design	CLABSI preventive measures	Quality improvement intervention	Results: measurements of adherence with CLABSI preventive measures	Results: CLABSI rate per 1000 catheter days
12	**Berenholtz et al (2014), 44 states, District of Columbia and Puerto Rico, USA, 1,564 ICUs**	Baseline: 6 months Intervention: 18 months Before-after study	**Baseline:** N/A **Intervention:** Effective hand hygiene 2% CHX skin antisepsis Full-barrier precautions, before CVC insertion Avoidance of the femoral route Daily review and CVC prompt removal	CUSP: Educate - Identify defects - Assign executive to adopt unit - Learn from one defect per quarter - Implement teamwork tools Use of CVC insertion and maintenance checklists Feedback	N/A	Baseline: 1.96 Intervention: 1.15 at 16 to 18 months after implementation IRR=0.57 (95%CI 0.50-0.65)
13	**Allen et al. (2014), USA, 2 ICUs**	Pre-intervention: Jan 2009 - July 2010 Intervention phase: Aug 2010 - Sept 2013 Before-after study	**Baseline:** N/A **Intervention:** Skin antisepsis with CHX Full barrier precautions Avoidance of femoral site	Simulation training of physicians with CVC insertion Audit: adherence with barrier precautions and hand hygiene Tailor-made CVC insertion carts Electronic CVC insertion documentation checklist by the assisting nurse	Compliance with: **Barrier precautions** increased from 81% to 100% **Hand hygiene** increased from 67% to 100%	Baseline: 2.03 Intervention: 0.76 (p = 0.007)

	Author / Country / Setting	Study period and design	CLABSI preventive measures	Quality improvement intervention	Results: measurements of adherence with CLABSI preventive measures	Results: CLABSI rate per 1000 catheter days
14	**Hansen et al. (2014), Germany, 32 ICUs**	Baseline: April 2006 - March 2007 Intervention: April 2007 - March 2008 Follow-up: April 2008 - March 2010 Before-and-after study	**Baseline:** Use of maximal barrier Use of impregnated CLs (antimicrobial or antiseptic) Dressing: Gauze-transparent dressing Disinfection of catheter insertion site at time of dressing change Hand disinfection before catheter insertion or maintenance Disinfection of catheter hub/stopcock or injection port before accessing the system **Intervention:** as baseline	Education: Lectures Administration of knowledge test Posters	N/A	Baseline: 2.29 Follow-up period: 1.64 RR 0.72 (95% CI 0.58-0.88)

	Author / Country / Setting	Study period and design	CLABSI preventive measures	Quality improvement intervention	Results: measurements of adherence with CLABSI preventive measures	Results: CLABSI rate per 1000 catheter days
15	**Sacks et al. (2014), USA, 1 surgical ICU**	Intervention: Jan 2006 - June 2006 Pre- post intervention study	**Baseline**: N/A **Intervention:** Insertion bundle: Effective hand hygiene Full-barrier precautions Skin antisepsis with CHX Avoid femoral Daily review for CVC necessity	CVC insertion checklist Training module Knowledge test to physicians and nurses: before-after Nurses empowered to stop the CVC insertion procedure if guidelines were violated Audit	**Intervention period:** Hand hygiene 100% Skin disinfection with CHX 93% Maximal-barrier precautions 100%. Use of subclavian insertion site 94% compliant	Baseline: 5.02 Intervention: 1.62, p<0.05

	Author / Country / Setting	Study period and design	CLABSI preventive measures	Quality improvement intervention	Results: measurements of adherence with CLABSI preventive measures	Results: CLABSI rate per 1000 catheter days
16	**Tang et al. (2014), Taiwan, 5 ICUs**	Baseline: March 2012 - December 2012. Intervention: March 2013 - Dec 2013 Before-after study	**Baseline**: N/A **Intervention:** CVC insertion bundle: Hand hygiene, maximal sterile barriers upon insertion, CHG for skin preparations, avoidance of the femoral vein CVC maintenance bundle: hand hygiene, proper dressing changes, aseptic technique for accessing and changing needleless connectors, and a daily review of catheter necessity	Education, central venous catheter (CVC) insertion bundle, process and outcome surveillance	Compliance of each CVC insertion component was: 100% for hand hygiene, 99.6% for the use of CHG 87.3% for maximal sterile barrier precaution 62.2% for optimal site selection	Baseline: 1.65 Intervention: 0.65 (p = 0.039).

	Author / Country / Setting	Study period and design	CLABSI preventive measures	Quality improvement intervention	Results: measurements of adherence with CLABSI preventive measures	Results: CLABSI rate per 1000 catheter days
17	**Thom et al. (2014), USA, 1 SICU**	July 2008 - March 2012 Quasi-experimental study	N/A	Unit-based quality nurse (8-hour weekday shifts to perform patient safety and infection control activities) Staff education: 5-minute video / web-based training course on central line care and maintenance Audit Feedback of performance Daily rounds with the clinical team Routinely monitoring central line dressings Weekly safety rounds with staff On the CUSP CLABSI initiative	N/A	Baseline: 5.0 Intervention: 1.5 (p<0.005)

	Author / Country / Setting	Study period and design	CLABSI preventive measures	Quality improvement intervention	Results: measurements of adherence with CLABSI preventive measures	Results: CLABSI rate per 1000 catheter days
18	**Entesari-Tafari (2015), Australia, 1 ICU**	July 2012 - July 2014 Before-and-after study	**Baseline:** N/A **Intervention:** Effective hand hygiene Full-barrier precautions Skin antisepsis (0.5% CHX in 70% alcohol or alcoholic povidone-iodine), before CVC Assistant wears mask and hat Internal jugular preferred Prompt CVC removal CVC maintenance procedure: Placement of a Biopatch Sterile line access Daily 2% chlorhexidine body wash	Informal training of physicians on CVC insertion CVC trolley Bedside audit by an observer with stopping rules Liaison nurse follow-up of all CVCs present at discharge	N/A	Baseline: 2.2 Intervention: 0.5 IRR=0.23 (95% CI 0.11-0.54, p=0.005)

	Author / Country / Setting	Study period and design	CLABSI preventive measures	Quality improvement intervention	Results: measurements of compliance with CLABSI preventive measures	Results: CLABSI rate per 1000 catheter days
19	**Latif et al. (2015a), Emirate of Abu Dhabi, 18 ICUs**	Baseline: June 2011-May 2012 Intervention: June 2012-Feb 2014 Before -after study	**Baseline**: N/A **Intervention:** Effective hand hygiene Full-barrier precautions Skin antisepsis with CHX Avoid femoral Daily review for CVC necessity	<u>CUSP</u>: Educate - Identify defects - Assign executive to adopt unit - Learn from one defect per quarter - Implement teamwork tools CVC insertion bundle Coaching webinars Content calls Peer-to peer mentoring Patient safety workshops Site visits Web-based platform Feedback	N/A	Baseline: 2.56 Intervention: 1.79 Reduction 0.62 (95% CI, 0.46–0.83)

	Author / Country / Setting	Study period and design	CLABSI preventive measures	Quality improvement intervention	Results: measurements of adherence with CLABSI preventive measures	Results: CLABSI rate per 1000 catheter days
20	**Álvarez-Moreno et al. (2016), Colombia, 4 ICUs**	Baseline: 3 months Intervention: Sept 2003 - April 2010 Before-after study	**Baseline: N/A** **Intervention:** Hand hygiene before CL insertion or manipulation Use sterile gauze or a transparent sterile dressing to cover the insertion site Change the gauze every 48 hours and the transparent dressing every 7 days Prompt removal of CVC Change the administration set every 96 hours; unless used for fat, nutrition, or blood precuts, and in these cases change every 24 hours Use CHX use for skin antisepsis Preferably use the subclavian vein Use maximal sterile barrier precautions during CL insertion Disinfect line hubs, needleless connectors, and infection ports before accessing the CL	Bundle of infection control interventions Education Audit Feedback of performance with: HH - Date on administration set - Placed dressing - Correct condition of dressing Feedback of CLABSI data Use an all-inclusive catheter cart or kit	Hand hygiene compliance, 50% vs 76% (p= 0.001) Compliance with date on administration set, 91% vs 87% (p=0.929) Compliance with placed dressing, 85% vs 82% (p=0.520) Compliance with correct condition of dressing, 86% vs 78% (p=0.110)	Baseline: 12.9 Intervention: 3.5 (p = 0.002)

	Author / Country / Setting	Study period and design	CLABSI preventive measures	Quality improvement intervention	Results: measurements of adherence with CLABSI preventive measures	Results: CLABSI rate per 1000 catheter days
21	**Lin et al. (2017), Taiwan, 17 ICUs**	Baseline: Jan 2009 - Dec 2010 Intervention: Jan 2011 - Dec 2013 Before-after prospective study	**Baseline: N/A** **Intervention:** Hand hygiene Maximal barrier precautions Alcohol - CHX skin antisepsis Optimal site for CVC Timely CVC removal	Technical innovations: chlorhexidine transparent dressings one-piece body drape all-inclusive catheter cart Education and training: lectures simulation training for new staff	Maximal barrier precautions compliance, 45.5% vs 73.9% Hand hygiene and Alcohol - CHX skin antisepsis >80% after the end of the intervention	Baseline: 9.27 Intervention: 7.55, p<0.001 31% reduction [IRR] 0.69; 95% CI 0.59-0.81

2.4.1 Review of the meta-analysis (Blot et al. 2014)

The meta-analysis by Blot et al. (2014) included 43 (n=43) studies published in English between January 1995 and June 2012. These involved mainly medical-surgical ICUs (n=584), they implemented QI interventions, and they used CDC definitions for CLABSI diagnosis (Blot et al. 2014). More than half of the studies were conducted in US hospitals, indicating the proliferation of QI interventions relating to CLABSI prevention in the US healthcare system. Eight studies were undertaken in Europe and the rest in Asia, Latin America and Australia. Meta-analysis included experimental and quasi-experimental studies. The meta-analysis included 35 before-and-after studies (n=35), one controlled before-and-after study (n=1) and seven interrupted time series (ITS) studies (n=7), in order to assess the impact of QI interventions on the incidence of CLABSIs. Authors have applied a comprehensive search strategy and a 27-item checklist in order to evaluate the methodological quality of the included studies (Downs & Black 1998). The assessed studies were scored according to criteria adapted for CLABSI prevention research. The Higgins I^2 test was predefined to quantify heterogeneity of the studies and to estimate the overall effect size ($I^2 \leq 25\%$ for low, $I^2 < 50\%$ for moderate, and $I^2 \geq 50\%$ for high heterogeneity).

Before-and-after trials showed reductions in the CLABSI rate (OR, 0.39 [95% CI, 0.33 – 0.46]; P < .0001) with high statistical heterogeneity (I2 = 85.4%), while analysis of the six ITS studies identified a change in level for the CLABSI rate at three months post-intervention (OR, 0.30 [95% CI, 0.10 – 0.88]; P = 0.028) with low heterogeneity (I2 = 4.5%). A sub-group analysis of before-after trials showed that CLABSI risk reduction was significantly stronger (P=0.026) in trials with care bundles or checklists (OR, 0.34 [95% CI, 0.27 – 0.41] than in those without them (OR, 0.45 [95% CI, 0.36-0.55]). There was no significant difference (P=0.18) between reported baseline rates above or below a suboptimal rate of 4.0 CLABSIs per 1000 catheter days. Furthermore, no significant difference (P = 0.06) was found between the high-power and lower-power studies.

The study by Blot et al. (2014) was the first meta-analysis which assessed before-and-after studies and demonstrated the beneficial effect of bundles and checklists as QI strategies to achieve CLABSI reduction. Although the use of bundles and checklists for both CVC insertion and maintenance is reported in the meta-analysis, only the frequency of use of insertion bundle items is demonstrated. This implies that most QI studies have focused on improving CVC insertion practices without providing an explanation of why CVC maintenance practices were not addressed, given that the guidelines recommend that all practices related to CLABSI prevention should be followed (O'Grady et al. 2011).

Up to 11 different QI strategies were employed in different combinations, usually implementing one to five of those strategies, namely education, bundles, checklists, audit and performance feedback, organisational and infrastructural changes. For the first time a wider view of the effectiveness of QI interventions related to patient safety is provided. However, data are lacking regarding which of the abovementioned QI strategies are more effective than others. This finding is in line with previous research that was unable to conclusively suggest which QI initiatives should be widely implemented (Ranji et al. 2007, Safdar & Abad 2008). Moreover, despite the meta-analysis identifying a positive impact of bundles/checklists on CLABSI reduction, it is not clear to what extent such bundles have influenced professional behaviour, since information about HCWs' adherence to the bundles is limited.

The assessed studies had high heterogeneity (despite there being a significant effect), which therefore hindered the study's external validity. Population characteristics, lack of randomised or controlled studies, and variability in baseline preventive practices have all contributed to the studies' heterogeneity. Although heterogeneity is an inherent problem in systematic reviews and meta-analyses (Higgins et al. 2003), a substantial clinical heterogeneity was also identified, since there was considerable variation in applied evidence-based preventive measures within the studies. The above results confirmed the effectiveness of QI interventions in reducing CLABSI rates – especially those interventions which included bundles/checklists. Nevertheless, studies published in 2013 and subsequently have contributed very little to the already proven effectiveness of CVC bundles (Ista et al. 2016).

2.4.2 Review of the twenty identified QI studies

Although surveillance and reporting of CLABSI rates were adequately described amongst the studies, reporting of which CLABSI preventive measures were in place before implementation of the interventions was inconsistent. Even though these practices were described at the baseline, adherence was not reported, thus making it difficult to understand whether the interventions had changed professionals' behaviour. Of the twenty studies, only seven provided data on before-and-after rates of adherence to CLABSI preventive practices, while two studies measured adherence only after implementation of the intervention. The majority of the studies focused on CVC insertion practices, indicating that implementation of maintenance practices is insufficiently studied. Only two studies assessed adherence rates to both CVC insertion and maintenance practices. No studies assessed HCWs' behavioural determinants influencing CLABSI prevention. The majority of the studies employed quasi-experimental, and in particular before- and-after, designs. It is argued that in using this design other unmeasured factors might have occurred at the same time as the intervention, resulting in variations in CLABSI rates (Cherifi et al. 2013). Only one study employed a randomised control trial (RCT) design to establish causality between the intervention and the outcomes. Only one study provided data regarding context, in order to assess the influence of context on outcomes and increase certainty that outcomes could be attributed to the intervention. No studies employed mixed methods, such as the use of surveys supplemented by non-participant observation, which have the potential to provide a more comprehensive understanding of the barriers and facilitators affecting CLABSI prevention.

The following sections critically examine the identified QI empirical studies (n=20) on CLABSI prevention through the implementation of QI interventions in ICU settings. The review of the studies also examines their baseline characteristics namely, where they were undertaken, what were the CLABSI rates at baseline and what was the adherence to CLABSI preventive practices. Such a review was considered essential to shed light on any reported contextual elements that may or may not have influenced the effectiveness of QI interventions and to identify gaps and limitations prior to the implementation of the interventions. Then, the employed QI interventions and evidence for their effectiveness are examined.

2.4.2.i CLABSI rates

Studies were undertaken in the USA (7/20), followed by Europe (5/20), Asia (6/20), Latin America (1/20) and other regions (1/20). The most used study design was a before-and-after test design with (n=2) or without (n=18) a control group. This design might overestimate the effect of the interventions, whilst a causal relationship between interventions and reduced infections may not be sufficiently established. However, Bion et al.'s (2012) four-cluster non-randomised study was implemented in a stepped before-and-after approach, which reduced the risk of bias. Marsteller et al.'s (2012) controlled experimental evaluation was the only study that reported an established causal relationship between the intervention and reduced CLABSI rates. All studies used the US Centers for Disease Control and Prevention (CDC) definition for CLABSI diagnosis (as presented in Chapter 1). However, very few studies reported validation of CLABSI data by independent observers.

The baseline CLABSI rate ranged from 1.5 (Lin et al. 2012) to 22.7 (Leblebicioglu et al. 2013) per 1000 catheter days. A high baseline incidence of CLABSI rates was linked to geographical distribution, addressing the burden of CLABSI for developing countries (Ista et al. 2016). However, multifaceted interventions in low/middle income countries and in hospitals with limited resources were as effective as in high income countries. Post-intervention CLABSI rates ranged from 0.5 (Entesari-Tatafi et al. 2015) to 12.0 (Leblebicioglu et al. 2013) per 1000 catheter days. CLABSIs were significantly reduced in 18 studies, while four studies reported a sustained reduction at 16–18 months, 19 months, 21 months and two years (Berenholtz et al. 2014, Marsteller et al. 2012, Hong et al. 2013, Khalid et al. 2013 respectively).

The success of the above studies in reducing CLABSIs confirms previous research, which has identified that CLABSIs are preventable (Blot et al. 2014, 2015). However, it is argued that context influences and interacts with the implementation process, thus explaining the mixed success of QI initiatives in a range of settings (Ovretveit et al. 2011). The following paragraphs provide an overview of the baseline contextual elements among the ICUs included in the studies reviewed. The aim was to determine whether studies have adequately described and/or assessed contextual elements related to CLABSI prevention prior to the implementation of the interventions.

2.4.2.ii Adherence to CLABSI practices before implementation of the intervention

In respect of the extent to which CLABSI preventive practices were implemented in each ICU prior to the implementation of the intervention, only four studies provided relevant baseline data. Cherifi et al. (2013) and Hansen et al. (2014) reported that they applied both CVC insertion and maintenance bundles in their units prior to the intervention. Bion et al. (2012) distributed an infection control practices survey questionnaire to establish baseline data in a large number of ICUs (n=223) in the UK, with a 57% response rate. The information collected primarily described what equipment was used in relation to CLABSI prevention. This limits the ability to establish baseline data with regard to CLABSI preventive practices in UK critical care settings. Jeong et al. (2013) reported that they targeted their CLABSI prevention efforts at hospital-wide hand hygiene initiatives prior to the intervention. In contrast, the implementation of CVC insertion practices was somehow neglected, as this was based on physicians' autonomous judgment instead of consistent adherence to the implementation of insertion bundles. It seems that participating ICUs within the reviewed studies were not able to provide baseline information with regard to CLABSI preventive measures. Indeed, monitoring of adherence to infection control practices is an expensive and resource-consuming process (Pronovost et al. 2006). However, the lack of baseline adherence data results in inadequate information about the scale of improvement in respect of behavioural change following implementation of the intervention (Pronovost et al. 2006, 2008c).

Baseline adherence rates to CLABSI preventive practices were reported in seven studies, although only two of these clearly described such practices (Cherifi et al. 2013, Hansen et al. 2014). In two studies (Jeong et al. 2013, Hansen et al. 2014) baseline adherence rates came from records and a survey questionnaire rather than from actual direct observation, which is considered the 'gold standard' approach for auditing infection control practices. Studies suggest that self-reported adherence to guidelines may exceed the objective rates and should not be used as the only measure of guideline adherence (Adams et al. 1999). However, Hsu et al. (2014) reported considerable variation in self-reported adherence to CLABSI preventive practices, suggesting that respondents were able to admit both high and low adherence.

It seems from the wider literature that CVC insertion practice has mainly been researched without a clear explanation being given regarding the reasons for such research. It is worth noting that studies usually refer to the implementation of evidence-based insertion practices when they discuss CLABSI prevention (Furuya et al. 2016). Only one study (Cherifi et al. 2013) reported and measured all CLABSI evidence-based practices (insertion, handling and site care) at the baseline. However, daily review of the necessity for a CVC, and of prompt removal of a catheter was not observed in any study during the pre-intervention period. Indeed, previous research has identified that the above element was the least implemented (30% in Sacks et al. 2014 and 30.4% in Furuya et al. 2016) among CVC insertion bundle elements. Jeong et al. (2013) have also reported medical resistance as the reason for not implementing this element. Adherence to hand hygiene, maximal sterile barrier precautions, CVC insertion maintenance (a term commonly used without a clear description as to whether this practice was about handling the CVC or care of CVC insertion site), and placement of correct dressing at CVC insertion site were mainly observed amongst the reviewed studies.

Rates of full adherence to CVC insertion bundles was observed in four studies. Adherence ranged from 0% (Jeong et al. 2013) to 100% (Cherifi et al. 2013). Allen et al. (2014) reported adherence only to maximal barrier precautions (67%). CVC maintenance and care were observed in five studies (Cherifi et al. 2013, Khalid et al. 2013, Jaggi et al. 2013; Leblebicioglou et al. 2013, Alvarez-Moreno et al. 2016); however, Khalid et al. (2013) did not provide adequate information about exactly which measures were included in the maintenance practice. Consequently, understanding about which ‘maintenance practices’ are less implemented is also limited. Cherifi et al. (2013) reported an adherence rate of 69% for CVC handling. Indeed, relevant literature has not researched CVC handling practice to the same extent as use of the CVC insertion bundle. Previous studies have reported the onset of CLABSI at 12 days (Guerin et al. 2010), while CLABSI rates were increased from 2.1/1000 catheter days to 4.5/1000 days at 1-5 central line days and 6 -15 central line days, respectively (McLaws & Burrell 2012). The researchers in these studies suspected that events occurring after CVC insertion might be responsible for the infections. Therefore, studies that broaden their CLABSI prevention strategies to include CVC handling and site care evidence-based practices may have an added benefit (Cherifi et al. 2013).

High adherence (82% – 95%) to correct placement of the CVC dressing was identified in four studies, indicating a consistency in CVC site care among the studies (Cherifi et al. 2013, Jaggi et al. 2013, Leblebicioglou et al. 2013, Alvarez-

Moreno et al. 2016). Baseline adherence to maximal barrier precautions was reported as high in two studies (81% and 100% in Allen et al. 2014 and Cherifi et al. 2013, respectively). In contrast, Jeong et al. (2013) reported 31% baseline adherence to the above practice. Research has shown that this bundle element may be the most effective preventive strategy among the five CVC insertion bundle elements (O'Grady et al. 2011). A previous study has also identified that its implementation increases the likelihood of CLABSI reduction by 2.2 to 6.3 times (Seddon et al. 2011). Jeong et al. (2013) identified that chlorhexidine skin antisepsis during CVC insertion had the lowest baseline adherence (0.0%), even though research has shown its effectiveness as an antiseptic agent during CVC insertion (Timsit et al. 2009, Mimoz et al. 2015). Jeong et al. (2013) considered that clinical practicalities, such as the time necessary for the agent to dry fully before the insertion, may hinder its optimal use by the staff inserting the CVC. Moreover, ICUs' habitual practices, such as the use of povidone-iodine skin antisepsis, might have deterred staff from using chlorhexidine instead.

Avoidance of the femoral vein at the CVC insertion site was high (94%) in Jeong et al.'s (2013) study at the baseline. CLABSI preventive guidelines (O'Grady et al. 2011) recommend the avoidance of the femoral vein as an insertion site. However, Marik et al. (2012) have identified that there is no difference in CLABSI rates when the femoral vein is used as an insertion site compared with the subclavian and internal jugular vein. It seems that it is unclear whether there is any benefit from avoidance of the femoral vein, although guidelines recommend otherwise. As previous studies have shown, scepticism among medical personnel regarding the evidence is a reason for non-adherence and suboptimal care (Cabana et al. 1999). Baseline adherence to hand hygiene prior to CVC insertion was shown to be suboptimal among five studies. Adherence ranged from 32% (Leblebicioglou et al.

2013) to 67% (Allen et al. 2014). Ineffective implementation of hand hygiene has been previously identified as a barrier to CLABSI prevention (Bonello et al. 2008). The above adherence rates suggest that variability in CLABSI preventive practices and lack of consistent application of guidelines still exist, despite the reported reduction in CLABSI rates since 1990 (Miller & Maragakis 2012). Even though all these practices are important to CLASBI prevention, comparison between studies is challenging. Moreover, baseline data about the adherence of critical care personnel to CLABSI evidence-based practices are also limited, thus creating an unclear picture of the magnitude of the non-adherence issue. Furuya et al. (2016) noted that use of CLABSI bundles is associated with lower CLABSI rates when adherence is high (>80%). The lack of such baseline information limits understanding of the opportunity for improvement and provides inadequate information about the extent of improvement after the intervention is implemented (Pronovost et al. 2008c). Moreover, not all CLABSI preventive practices were assessed. It appears that performance measurement for all bundle elements may require extra time and resources (Pronovost et al. 2006). Ista et al. (2016) have identified that among 79 QI studies no more than a third reported that they measured adherence with CVC practices.

2.4.2.iii Baseline contextual elements within studied ICUs

Inconsistent measurement and reporting of contextual factors related to CLABSI prevention prior to the intervention limits the ability to understand which contextual elements support or hinder the achievement of intended effects. Thus, little is known about what kinds of processes should be targeted through the QI intervention in order for beneficial changes in behaviour to be achieved. Stevens and Shojania (2011) have argued that the lack of a comprehensive focus on context in QI efforts is the reason for heterogeneity when evaluating both clinical practices aimed at patient safety and successful QI interventions.

Context in relation to CLABSI prevention was poorly described at the baseline in the reviewed studies, while nine studies provided no information about the ICU context (Marsteller et al.2012; Hong et al. 2013; Palomar et al.2013; Berenholtz et al. 2014; Sacks et al.2014; Tang et al. 2014; Entesari-Tatafi et al. 2015; Latif et al.2015; Alvarez-Moreno et al 2016). Two studies reported that the ICUs were already equipped with central line carts including all supplies for CVC insertion (Allen et al. 2014, Cherifi et al. 2013). CVC insertion trolleys, carts or kits have been identified as facilitators of adherence to CVC insertion practices (Pronovost et al. 2006). Cherifi et al. (2013) reported 100% adherence to CVC insertion practice prior to the intervention. Availability of the required CLABSI supplies was also inconsistent within hospitals and between countries. Some hospitals reported that they were supplied with disposable CLABSI prevention equipment in the UK (Bion et al. 2012), while the same equipment was not available in Belgian ICUs (Cherifi et al. 2013). Bion et al. (2012) surveyed 223 ICUs prior to the intervention. They identified that there was great variability within the ICUs with regard to the disposable equipment required for CLABSI prevention; for example, use of needleless connectors versus use of a 3-way tap. This highlights that lack of resources can be a barrier to effective implementation of best CLABSI practice.

Written policies for CLABSI preventive measures that were available and accessible for all HCWs were reported in three studies (Allen et al. 2014, Cherifi et al. 2013, Hansen et al. 2014). Jeong et al. (2013) had already engaged the ICU staff in strict education prior to the intervention. However, the hospital had begun preparing for accreditation a year before the beginning of the intervention, and several contextual structures had already been in place. Two studies reported that they had actively participated in the International Nosocomial Infection Control Consortium (INICC) surveillance programme at least four months prior to the intervention (Jaggi et al. 2013, Leblebicioglu et al. 2013). Bion et al.'s (2012) study took place in a period when concurrent preceding efforts had started to focus on HCAI prevention. However, in the absence of a national reporting surveillance system at that time (2009), the impact of those initiatives on CLABSI rates could not be identified. It appears that there was a national interest in the UK regarding combating HCAIs prior to the intervention, which might already have resulted in some CLABSI reduction before the beginning of the intervention.

Two studies (Lin et al. 2012, Khalid et al. 2013) provided data on ICUs' structural deficiencies that have previously been identified as manageable and widely applicable ways of reducing HCAIs (Zingg et al. 2015). The nurse-to-patient ratio was reported as one-to-one or one-to-two, while the ICU was covered by an in-house intensivist round the clock on a daily basis, indicating an efficient level of staffing in Khalid et al.'s (2013) study. However, the nursing staff was extremely diverse (13 nationalities), which contributed to poor and ineffective implementation of CLABSI practices. It appears that continuous in-service education and training was not in place, which may reflect the ICU's high CLABSI rates, despite the nurse-to-patient ratio being adequate. Only one study examined the reasons behind the unit's high CLABSI rates prior to the intervention (Khalid et al. 2013). Researchers in that case used a root-cause analysis approach to depict the weak links in the process of implementing CLABSI measures. It was identified that hand hygiene, frequency of CVC site dressing changes and the overall CVC bundle were suboptimal. The next step was for the researchers to develop strategic interventions based upon identified contextual barriers.

An explanation for the performance variation discussed in Section *2.4.2.ii* might be the contextual characteristics of each ICU and not the efficacy of the clinical bundles themselves; an intervention that works in one setting does not necessarily work in another (Kringos et al. 2015). Infection control literature has strongly supported the view that the use of guidelines does not necessarily give rise to appropriate behaviour in health care (Larson & Kretzer 1995). Changing human behaviour is the 'Holy Grail' of infection control, but unfortunately human nature dictates that, given a choice between two competing behaviours, some will choose wrongly, often despite the best intentions (Young et al. 2006). QI interventions aiming to enhance the uptake of evidence-based practices have had modest effects. Therefore, it is necessary to better understand the multitude of factors that affect the attitudes and behaviours of HCWs, while QI interventions should be planned on the basis of behavioural science theory in order to establish a scientific rationale for the selection of interventions that translate research into clinical practice (Walker et al. 2003, Mitchie et al. 2011).

2.4.3 Implementation of multifaceted quality improvement strategies

Quality improvement interventions have applied a wide range of structural, organisational, and management activities that have been identified as being crucial to effective implementation of CLABSI preventive programmes (Zingg et al. 2015). The variability and mixed success of QI interventions relating to CLABSI prevention have led researchers to turn their attention to the organisational complexities and processes which serve as either facilitators of, or in their absence barriers to, behavioural change related to CLABSI prevention (Krein et al. 2010). In order for them to be discussed, quality improvement strategies were classified according to a modification of the taxonomy used in a previous review (Ranji et al.

2007): i) bundles and checklists, ii) education and training, iii) audit and performance feedback, and iv) organisational changes.

2.4.3.i Bundles and checklists

All 20 reviewed multifaceted QI studies have implemented bundle/checklist practices as part of their QI strategy, confirming the results of Blot et al.'s meta-analysis (2014) in relation to the effectiveness of bundles/checklists in CLABSI prevention. Inconsistency in applied CVC practices was also apparent during the intervention phase in respect of the implementation of CVC practices (insertion, handling and dressing change) as well as of the individual elements of CVC bundles. Although most studies have implemented CVC insertion practices through bundles and checklists, not all five bundle elements of the former practice were applied. O'Grady et al. (2011) supported the view that adherence with all components of the bundle serve as benchmarks for quality assurance and performance improvement, while targeting only CVC insertion practices does not eliminate the occurrence of CLABSIs.

CVC maintenance bundles were applied during the intervention in 10 of the included studies. Bion et al. (2102) applied an aseptic CVC access technique along with daily review of CVC sites. Hong et al. (2013) reported the challenges of standardising CVC maintenance practices during the intervention period, and they suggested that future studies should focus not only on CVC insertion but also on maintenance practices. Entesari-Tatafi et al. (2015) also emphasised the crucial role that CVC maintenance practices play in CLABSI prevention, as they have identified that their care bundle (including a novel maintenance bundle) has sustained CLABSI rates at 0.5/1000 catheter days for two years. Despite this, it was not feasible to estimate the effects of insertion and maintenance bundles with full certainty, since both practices contributed to CLABSI reduction (Ista et al. 2016). Nevertheless, although CLABSI prevention bundles have shown their capacity to prevent infection, the continued prevalence of CLABSIs in hospitals worldwide implies that the implementation of these strategies may remain problematic (Thom et al. 2014).

2.4.3.ii Education

Most of the reviewed studies used various forms of education. Up to seven different types of educational modalities were used in different combinations. These modalities varied from traditional didactic lectures to a standardised comprehensive credential module. The content of the applied education varied among the studies in relation to structure, duration, the mode of its delivery, and whether or not attendance was mandatory. Bion et al. (2012) provided two training days, including small group interactive sessions, in order for technical and non-technical activities to be discussed and clarified. Although the abovementioned activities were presented with some details in a table format, it was not clear whether these two training days were sufficient for the staff to be adequately trained in CVC insertion. Jeong et al. (2013) provided more information with regard to the applied education, which was focused on all staff – employees and trainees. Physicians and nurses were trained regarding CVC insertion at the bedside in the ICU and in the operating room, while trainee physicians were educated by the task force team. Articles related to CLABSI prevention were also distributed to them.

Moreover, educational activities targeted at new practitioners were provided, while existing HCWs were retrained if required. Khalid et al. (2013) provided an extensive education programme to a diverse group of both physicians and nurses, coming from various ethnicities and nationalities and with differing backgrounds of training and experience. Khalid et al's (2013) goal was to raise the staff's awareness of their own responsibility for reducing CLABSI rates and to have 'zero tolerance' for infections. For that purpose, a dedicated clinical educator was assigned to night shifts in order for HCWs to be provided with consistent training throughout the shifts.

Web-based education was utilised by Bion et al. (2012), Sacks et al. (2014) and Thom et al. (2014). Web-based education and training is an economically and cost-effective option for clinical training in infection control and prevention (ICP), and it coincides with advancements in informatics within ICUs. Labeau et al.'s study (2016) supported its effectiveness, as it has yielded significant immediate and residual learning effects. Seven studies (Bion et al. 2012, Lin et al. 2012, Marsteller et al. 2012, Hong et al. 2013, Palomar et al. 2013, Berenholz et al. 2014, Latif et al. 2015a) have targeted HCWs' education beyond training and in CLABSI prevention. These studies have adopted Pronovost et al.'s (2006) educational framework, which aimed to educate staff in the science of safety in order for them to understand systems change and safe design. Guidance on safety issues, clinical stories and safety incidents and educational videos on safety issues were provided to all staff at a centralised national level. However, it was not clear to what extent they have implemented the educational model applied by Pronovost et al. (2006, 2008a) indicating studies' adaptability to local context. Pronovost et al. (2008) have given prominence to staff education as playing a critical role within a broader strategy for leading change. Thus, their educational framework was also applied to executive leaders, team leaders, and frontline staff by achieving an overall improvement in ICUs safety culture. Two recent studies (Allen et al. 2014; Lin et al. 2017) used a simulation approach to train physicians in CVC insertion practice. However, Allen et al. (2014) argued that simulation although it has shown to improve outcomes, it has little value if physicians are not properly supervised at the bedside. Simulation-based education has been identified as a highly cost-effective intervention to train physicians in CVC insertion and to prevent the occurrence of new CLABSI (Cohen et al. 2010), suggesting that in the era of technology simulation can play a key role to build physicians and nurses skills without compromising patient's safety and by providing immediate structured feedback to the staff (Barsuk et al. 2015).

The impact of education on HCWs' knowledge and competency through a pre-post assessment was assessed in Sacks et al.'s (2014) study, while in Thom et al's (2014) study physicians' and nurses' competency was assessed only post-intervention. Although an increase in knowledge does not necessarily lead to fewer infections or greater adherence to best practices, a comprehensive awareness of evidence-based practices related to CLABSI prevention is a first and significant step in increasing knowledge about best practice (Ward 2012). Labeau et al. (2009) identified through a survey of a large sample of European critical care nurses (n=3405) that their knowledge of CLASBI prevention was suboptimal (mean test score: 44.4%). Given the wide discrepancy in CLABSI preventive practices, and the lack of consistent adherence to guidelines, it is suggested that a further improvement of critical care nurses' knowledge is required. There are some points to be considered in relation to the effectiveness of education on reduction of CLABSI rates. Most studies have suffered from a lack of a comprehensive description of their programme content, the baseline assessment of recipients' knowledge was inadequately reported, and inadequately validated educational tools were used. For these reasons, the wider use of similar educational programmes is hindered (Safdar & Abad 2008).

2.4.3.iii Audit and performance feedback

Considerable variability is demonstrated among studies in relation to frequency of audit practice. Frequency of audits ranged from monthly to daily, intermittently or every time a CVC was inserted. Variability also existed in relation to the individual who performed the audit process. Auditors were mainly the nursing staff: bedside nurses, nurse educators and clinical nurse specialists. Those nurses who observed physicians during CVC insertion were empowered to stop the procedure in the event of all processes not being followed. Various observation tools were used by the studies, checklists being reported as the most frequently used tool. However, researchers have not applied validated audit tools to allow comparison between hospitals.

Performance feedback was given to the ICU staff in six of the 20 studies. Feedback was provided directly to the staff through discussions (Khalid et al. 2013, Thom et al. 2014), on a weekly (Jeong et al. 2013) and monthly basis (Cherifi et al. 2013). Twelve studies provided feedback to the staff on the monthly CLABSI rates. Considering that CLABSI rates were reduced in these studies, the absence of feedback to the staff regarding CLABSI rates has not enabled them to feel motivated in relation to their sustained efforts, or to feel a sense of progress (Dixon-Woods et al. 2011).

2.4.3.iv Organisational changes

The existing mixed success of QI strategies among hospitals has increased recognition of the importance of organisational context in QI science. Krein et al.'s (2010) mixed method study, assessing QI efforts to prevent CLABSI, has identified that similar applied QI strategies resulted in various outcomes within different organisational contexts. Researchers have emphasised that it is necessary to measure, or at least take into account, the organisational context as a source of mixed success and quality variation when implementing QI preventive strategies. Few studies have shed light on why, how and which QI strategies, considering their organisational context, have the greatest likelihood of reducing CLABSIs (Kirkland et al. 2012). Lack of such insights limit the ability, firstly to understand why some QI interventions work in one setting and not in another, and secondly to better advise policymakers and managers regarding the effectiveness of various improvements, given the organisational conditions in which they function (Ovretveit et al. 2011).

Several studies have previously identified organisational contextual factors which have influenced infection control and prevention (Krein et al. 2010, Ovretveit et al. 2011, McAlearney et al. 2013, Zingg et al. 2015). Facilitators of CLABSI programme success were leadership, culture, teamwork, nursing staff empowerment, and interdisciplinary rounds. Insufficient time or resources, and lack of organisational support and structures, were identified as barriers to effective CLABSI prevention. Safety culture was assessed in Hong et al.'s (2013) study, which adopted Pronovost et al.'s (2005) comprehensive unit-based safety programme (CUSP). Although more studies reported that they had adopted the latter, neither the safety culture was assessed nor were explanations provided (Marsteller et al. 2012, Lin et al. 2012, Bion et al. 2012, Palomar et al. 2013, Berenholtz et al. 2014, Latif et al. 2015a). It is therefore uncertain as to whether the same intervention applied in different contexts has improved perceived safety culture, communication and leadership. Local leadership differences were suggested as a possible cause for the intervention not delivering the same results (Dixon-Woods et al. 2013).

Leadership (through effective team work) and communication (culture) were reported among studies as facilitators of CLABSI reduction, although their impact was not directly assessed (Lin et al. 2012, Palomar et al. 2013, Latif et al. 2015a). Through interviewing key informants in various roles from eight hospitals, previous research has identified that leadership through support from the hospital administration, and approachability of infection control champions, may be critical to the success of CLABSI prevention programmes (McAlearney & Hefner 2014). Support from systems leadership, through physicians and nurses' leaders, has internally motivated frontline staff to implement the correct evidence-based practices addressing CLABSI prevention (Krein et al. 2010; McAlearney & Hefner 2014).

Thus far, it was shown that over the last decade there has been an unprecedented interest in improving patient safety through the use of multifaceted QI methods aimed at reducing HCAI rates and improving adherence to best practice. However, the literature review has highlighted what previous research had already acknowledged; the impact of these multifaceted QI initiatives in healthcare is positive but limited (Schouten et al. 2008), as little is known about why certain QI interventions are successful in some hospitals and not in others (Krein et al. 2010). For example, Pronovost et al's landmark study (2006) reported significant reductions in CLABSI rates among 108 ICUs, with such reductions being sustained for 14 to 18 months. However, as the above researchers reported, the reduction in CLABSI achieved among the participating hospitals was not uniform, and their study's design did not provide an explanation for this variability (Ovretveit 2011).

2.5 Gap in knowledge

The majority of the reviewed studies have employed an uncontrolled research design, and hence their ability to make a causal connection between the intervention and reduction in CLABSI rates was hindered. The adoption of randomised controlled trials (RCTs) provides a rigorous testing method to determine whether, why and where an intervention is effective (Auerbach et al. 2007). However, authors have argued that using RCTs to improve quality of evidence may not apply to QI (Schouten et al. 2008, Benn et al. 2009, Mauger et al. 2014). Most QI interventions are complex in nature, and they are implemented in 'real world' settings with a number of well-known confounding factors which are difficult to eliminate as the intervention evolves over time. The use of other research designs, such as the mixed methods research which includes both qualitative and quantitative data, may enable researchers to meet the complex challenges that underlie QI interventions and enhance the evidence of QI interventions. It seems that a compromise between scientific rigour in research design, and the ability to understand and describe those processes and mechanisms that dynamically evolve over time, may be necessary in improving the evidence of QI interventions (Benn et al. 2009).

The review of the literature has shown that QI programs are effective in reducing CLABSI within an ICU setting (Blot et al. 2014); however, inconsistencies in practices related to CLABSI prevention largely remain. Auerbach et al. (2007) argued that, although some solutions are obviously effective in improving patient safety (for example, the case of hand-washing in reducing HCAIs), effective strategies that consistently result in improved hand-washing remain elusive. Various QI multifaceted interventions were employed amongst the reviewed studies;

however, there is limited reporting on the context in relation to CLABSI prevention interventions, a lack of knowledge about which contextual factors are important determinants for changing practice, and little is known about the causal mechanisms between contextual features, intervention and outcomes (Davidoff 2009, Kaplan et al. 2010, Taylor et al. 2011). Therefore, it seems that although Pronovost et al's landmark study (2006) gave a momentum in the assessment of culture safety towards CLABSI prevention, however, later research on CLABSI prevention provided limited contribution on the assessment of context with regards to CLABSI prevention. Dixon-Woods et al. (2011) supported the view that studying the context of QI interventions is imperative in order to identify why an intervention works in one setting but not in another, and to inform decisions that involve real-world interventions (Davidoff 2009). An example of the above is Bion et al's study (2012), which aimed to repeat Pronovost et al's study (2006) in the UK context. However, contextual, unexplored factors did not allow Bion and his colleagues (2012) to reach findings similar to Pronovost et al's (2006) study. Thus, the question of why, when and where an intervention is most successful is of great importance and has significant practical implications.

With regards to the discrepancies in HCWs' adherence to CLABSI preventive evidence-based practices in the reviewed studies, it is evident that translating research into practice is a slow and challenging process; the mere existence of guidelines cannot ensure change in practice (Walker et al. 2003). Behavioural theorists have recognised that behavioural change interventions are more likely to be effective if all possible mechanisms of actions are systematically investigated using a rational approach (Michie et al. 2008). Therefore, QI interventions should be planned on the basis of behavioural science theory, in order to establish a scientific rationale for the selection of interventions that translate research into clinical practice, and to enable the explanation of clinical behaviour in terms of factors that are amenable to change (Walker et al. 2003, Grimshaw et al. 2004, Mitchie et al. 2011). Very few of the reviewed studies have assessed all CLABSI preventive practices (insertion, handling and site care) either prior to or after the implementation of the intervention, thus limiting the ability to assess the full impact of CLABSI evidence-based practices. Moreover, although CLABSIs rates were effectively reduced little is known whether HCWs behavior changed and if it was sustained.

Based on the extensive literature review undertaken in order to conduct the present study, it became apparent from almost all the reviewed studies, aiming toward QI, not only that they were complex but more importantly that the did not sufficiently clarify why they were successful. Furthermore, it also became apparent that context was not assessed as an important factor influencing the success of QI interventions. This study therefore adopted a mixed-method approach in order to assess and shed light to the contextual influences of a Greek medical ICU, to develop and evaluate the effectiveness of an intervention targeting the reduction of CLABSI rates. Moreover, behavioural determinants of critical acre personnel were identified at baseline to understand why HCWs exhibit specific behaviours related to CLABSI prevention and not others. Understanding the abovementioned issues can help researchers and clinicians to reiterate the improvements to their settings and to further develop the intervention.

2.6 Summary and conclusion

In summary, this chapter examined previous empirical QI and multifaceted interventions towards CLABSI prevention and special reference was made to seminal study by Pronovost et al. (2006). Researchers not only achieved to reduce CLABSI rates in 108 ICU settings, but they also provided some evidence about unit's culture safety before and after the intervention. However, HCWs adherence to CLABSI preventive practices were not assessed. A later meta-analysis (Blot et al. 2014) on CLABSI prevention was discussed. Although it provided evidence that the use of bundles/checklists has a profound risk reduction to CLASBI development, it confirmed that there was high heterogeneity amongst the included to meta-analysis studies (n=43). Then, twenty empirical studies were examined with regards to their baseline characteristics and to the QI interventions they implemented, namely bundles, checklists, education, audit and feedback and organisational changes. This review identified a gap in knowledge in relation to why and how these QI interventions achieved their results. Having regard to the existing variability in CLABSI performance, and the lack of information about why HCWs apply some CLABSI preventive practices and not others, further research in this field is warranted if designers of QI interventions towards CLASBI prevention can make changes, improvements and disseminate them to other settings. The next chapter examines the underpinning theory of the present study. It also discusses the research design and methods that were used to collect data in the present research.

Chapter 3: Underpinning theory and study design

3.1 Introduction

It is important to recognise that the majority of healthcare-associated infections (HCAIs) result from cross-transmission of pathogens due to inappropriate implementation of evidence-based infection control practices. Although implementation of evidence-based guidelines could prevent as many as 65% to 70% of central line-associated bloodstream infection (CLABSI) cases, adherence rates are still suboptimal among healthcare workers (HCWs) (Umscheid et al. 2011). Given that clinical practice is formulated by human behaviour, improving evidence-based clinical practice requires changing the behaviour of many professionals. Research suggests that, in developing an intervention directed at healthcare professionals, the use of a theory of behavioural change provides a scientific rationale for the choice of interventions (Walker et al. 2003, Michie et al. 2011). Behavioural theories have previously been applied to assessing clinical professionals' reasons for non-adherence to guidelines, for example with regard to hand hygiene. However, such theories have not been widely used to inform the development of preventive QI (quality improvement) interventions. Consequently, efforts to explain the variations in the success of implementation of infection control programmes within various settings have been hindered (Michie et al. 2011, Cane et al. 2012, Sax et al. 2013). This chapter presents the theoretical basis for the study. It also presents the research design required to meet the study's aims and objectives, in the light of the gap in knowledge identified in Chapter 2.

3.2 Theoretical model of the study

It has been established that research findings are not always embedded successfully within daily practice in a timely and reliable fashion. Grimshaw et al. (2004) reported that 30% to 40% of patients do not receive care that is based correctly on relevant guidelines, and, equally alarmingly, 25% of patients receive an inappropriate or potentially harmful treatment. Michie et al. (2008) have argued that there are three principal reasons for advocating the use of theory in developing quality improvement interventions. First, interventions are likely to be more effective if they address the causal determinants of behaviour. Second, theory can be tested, and further developed, by evaluating the interventions only if mechanisms of action are theoretically informed. Third, theory-based interventions facilitate an understanding of why they worked, and thus they constitute a basis for developing better theory encompassing different contexts, populations, and behaviours.

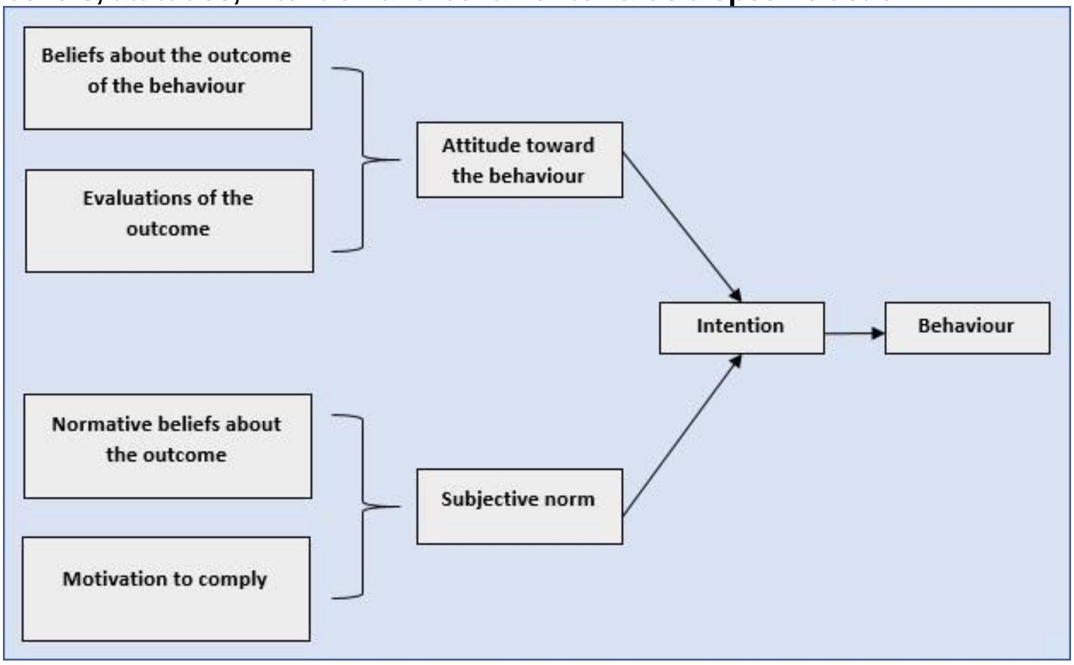
The present study was underpinned by the Theory of Reasoned Action (Fishbein & Ajzen 1975) and the self-efficacy construct by Bandura (1986). The Theory of Reasoned Action has been effectively applied to understand and modify a wide range of health behaviours (Godin et al. 2008; Smith-McLallen & Fishbein 2008). Theory of Reasoned Action assumes that individuals have control over the behaviour being studied (Fishbein & Ajzen 1975, De Vries et al. 1988). However, as there are external factors that influence critical care physicians and nurses when implementing CLABSI preventative measures, the construct of self-efficacy (Bandura 1986) was used in combination with Theory of Reasoned Action. Self-efficacy is an important determinant in initiating and maintaining behavioural change, while it can also be used to explain a complex set of behaviours. Theory of Reasoned Action was used in the present study because it was previously applied in an infection control context for identifying nurses behavioural determinants for non-adherence to hand hygiene guidelines (De Wandel et al. 2010). Additionally, clear methodological guidelines for instrument development using the Theory of Reasoned Action were available (Francis et al. 2004, Montano

& Kasprzyk 2008). The abovementioned concepts are described in the following sections.

3.2.1 Attitude and social influence concepts within the Theory of Reasoned Action

Theory of Reasoned Action is a social psychological theory that attempts to predict and understand why an individual may perform certain behaviours (Fishbein & Ajzen 1975; Ajzen & Fishbein 1980). Theory of Reasoned Action focuses on theoretical constructs concerned with individual motivational factors, as determinants of the likelihood of performing a specific behaviour. Theory of Reasoned Action assumes that the best predictor of a behaviour is 'behaviour intention', which in turn is determined by attitudes toward the behaviour and social normative perceptions regarding it. Figure 3.1 demonstrates how behaviour can be explained according to the Theory of Reasoned Action. The theory assumes that people behave rationally, and their intention to act is generally the result of considerable mental deliberation (Fishbein & Ajzen 1975).

Figure 3.1: Schematic presentation of the *Theory of Reasoned Action* relating beliefs, attitudes, intention and behavior towards a specific action.



Adapted from *Belief, attitude, intention and behavior: An introduction to theory and research* by Fishbein, M. & Ajzen, I. 1975. Reading, Massachusetts: Addison-Wesley Publishing Company.

‘Behaviour Intention’ in the Theory of Reasoned Action is described as the extent to which a person is motivated or willing to perform a certain behaviour. ‘Behaviour’ is the result of intention to act. As a general rule the stronger the behaviour intention, the more likely the performance of the behaviour (Ajzen & Fishbein 1988).

The above theory postulates two conceptually independent determinants of ‘behaviour intention’. The first is the ‘attitude’ toward the behaviour; this refers to the degree to which the person has a favourable or unfavourable evaluation of a particular behaviour. According to Theory of Reasoned Action, ‘attitude’ is determined by the individual’s existing beliefs about the outcomes of performing the behaviour, namely behavioural beliefs in conjunction with the evaluations of those outcomes (Montano & Kasprzyk 2008). Behavioural beliefs are defined by the person’s subjective evaluation of the probability that performing a particular behaviour will produce specific results; for example, whether behaviour that is linked to success will be sustained, and vice versa. Thus, a person who holds strong beliefs that the valued outcomes from a behaviour are a success or failure will have a positive or negative attitude toward that behaviour (Montano & Kasprzyk 2008).

The second determinant of ‘’behaviour intention’’ is a social factor termed ‘subjective norm’, which refers to the perceived social pressure to perform or not to perform a particular behaviour. This is determined by a person’s normative beliefs – that is, whether important individuals approve or disapprove of performing the behaviour, in conjunction with the person’s motivation to adhere with the wishes of those important individuals. A person who believes that certain people, whom he/she regards as important, think that he/she should perform a behaviour, and is motivated to meet the expectations of those people, will hold a positive subjective norm. Conversely, a person who believes that the people whom he/she regards as important think that he/she should not perform the behaviour will have a negative subjective norm, while a person who is less motivated to adhere with those people will have a relatively neutral subjective norm (Montano & Kasprzyk 2008). Positive feedback from a colleague, as a reaction to adequate implementation of evidence-based measures during insertion of a central venous catheter (CVC), would be an example of social support in the intensive care unit (ICU). Moreover, an individual leader who conveys values through their own behaviour (a role model) is also an example of a positive social influence (Larson et al. 2000).

The Theory of Reasoned Action assumes a causal chain linking behavioural and normative beliefs to behaviour intention and linking behaviour to attitude (toward behaviour) and subjective norm. This means that people are likely to perform a particular behaviour when they evaluate it positively and believe that other significant individuals think that they should perform it (Ajzen & Fishbein 1980, Montano & Kasprzyk 2008). Ajzen and Fishbein (1980) indicate that a measure of attitude and subjective norm can be obtained directly and indirectly. ‘Direct measurement’ is when the respondents are being asked directly about-for example, their overall attitude towards the behavior. ‘Indirect measurement’, on the other hand, is when respondents are being asked about specific behavioural beliefs and outcome evaluations-for example, what a specific behaviour means to them and what they believe would be the outcome of that specific behaviour. An essential step in the application of Theory of Reasoned Action is to conduct a preliminary study (an elicitation study) to identify relevant behavioural beliefs for the targeted behaviour and the target population (Montano & Kasprzyk 2008).

3.2.2 Self-efficacy

The concept of self-efficacy was used as a determinant of HCWs' intention to implement evidence-based CLABSI preventive practices. This concept was used, as Theory of Reasoned Action assumes that people have volitional control over the behaviour of interest. This implies that they can perform the behavior if they so desire (Ajzen, & Fishbein, 1980). Even in clinical settings with optimal conditions however, adherence to CLABSI preventive practices is not 100%, thus certain causes beyond HCWs capability can lead to less successful performance. Self-efficacy is central to Bandura's (1986) social learning theory and has been defined as 'the individual's belief in his capability to produce given behaviour when faced with a variety of challenges without relapsing to former behaviours' (Bandura 1997, McAlister et al. 2008). A major appeal of self-efficacy belief in health behaviour is that self-efficacy can be modified, because its sources come from personal experiences, motivation and persuasion provided by observing or modelling others (Viswanath 2008). In order to achieve behavioural change, individuals must believe that their current behaviour is not desirable and that a change in behaviour will be advantageous; they must also feel competent to overcome perceived barriers and to initiate the behaviour. This implies that the harder the individual tries, the greater the likelihood that he/she will achieve his/her behavioural goal. Assessment of self-efficacy reflects the level of difficulty that individuals believe they can surmount, and according to Bandura (2006), individuals who do not believe that they possess the power to produce the desired outcomes will have little motivation to achieve them (Bandura 2006).

3.3 Aims and objectives of the study

The aim of this study was to develop, implement and test the effectiveness of a theory-based intervention aimed at preventing CLABSIs within a medical intensive care unit (ICU). The behavioural determinants of critical care physicians and nurses were assessed, along with contextual elements, in order to target theoretically informed mechanisms of action. In the light of the gaps identified in the literature (see Chapter 2), the study's research question and specific objectives were formulated. Specifically, these were as follows:

Research question

Can a multifaceted theory-based intervention reduce central line-associated bloodstream infection (CLABSI) rates and improve adherence to CLABSI evidence- based practices within a medical ICU?

Objectives

- Identify the behavioural determinants (self-efficacy, behaviour intention, attitudes, social influence, and motivation) of HCWs toward CLABSI prevention in multiple sites;
- Identify contextual influences on the implementation of CLABSI preventive practices in a single site;
- Establish HCWs' adherence to evidence-based CLABSI preventive practices in a single site;
- Develop an intervention based upon baseline behavioural and contextual elements;
- Implement the intervention within a single site;
- Evaluate the effects of the intervention on:

    a. CLABSI rates

    b. adherence to evidence-based CLABSI preventive practices (CVC insertion, handling and site care)

    c. knowledge about CLABSI prevention

    d. contextual influences (culture, leadership and evaluation of practices) and behavioural influences (self-efficacy, attitudes, behavioural beliefs, subjective norm and normative beliefs) in the implementation of evidence-based CLABSI preventive practices.

3.4 Research design

An uncontrolled before-and-after design was used to investigate whether CLABSI rates and adherence to evidence-based CLABSI preventive practices changed in a medical ICU after the implementation of an intervention. It was not possible to include a control ICU as CLABSI data are not routinely collected in all Greek ICUs. The uncontrolled before-and-after design is one of the more commonly used methods in safety studies and is superior to observational studies, as the latter cannot suggest causation (Thiese 2014). However, the results from studies using a before-and-after design have to be interpreted with caution. Uncontrolled events occurring within the before-and-after study period can alter responses to the ‘after’ measurements, while the magnitude of the benefit of using such designs can be overestimated (Eccles et al. 2003; Fan et al. 2010). In this case, the before-and-after design was selected to assess the effectiveness of the study’s intervention, since controlled or randomised designs were not feasible. This study was designed to test the effectiveness of the intervention and establish whether this approach could feasibly be implemented in a full-scale trial, it could therefore be considered a pilot study for future work.

A mixed method approach was used to collect data for this study. The value of using multiple methods lies in the combination of quantitative and qualitative research in order to exploit their particular strengths, thus deepening the understanding of the topic under investigation and providing stronger and better inferences (Polit & Beck 2006; Tashakkori & Creswell 2007). The mixed method approach appears to enhance research when the increasing complexity of healthcare is to be investigated. Specifically, an ICU presents a complex environment where sophisticated equipment, personal interactions, team performance, societal norms and other elements all impact on patient outcomes. Mixed methods may therefore be an approach well suited to investigating these factors in the complex context of an ICU (Sax et al. 2013).

Survey questionnaires and non-participant observation were used, to closely examine the barriers and facilitators in the implementation of evidence-based CLABSI preventive practices in the ICU context. Observation of the context, and informal discussions with staff, were used to understand the contextual elements that influence HCWs to use certain CLABSI practices but not others. A survey questionnaire was used to measure healthcare personnel's behavioural and contextual influences regarding CLASBI prevention, while structured observation of CLABSI preventive practices was applied to assess the extent of non-adherence. The combination of quantitative and qualitative data can create a solid foundation for drawing conclusions about why HCWs exhibit specific behaviours related to CLABSI prevention; thus, a more comprehensive framework can be provided, through which the development of the study's intervention has a better chance of being successful.

CLABSI data were collected during four periods (the pre-baseline, baseline, intervention and post-intervention periods). The baseline assessment in the medical ICU lasted four months. Quantitative and qualitative data were collected during this period to establish baseline behavioural and contextual characteristics. The intervention was implemented during a period of six months. Quantitative data were collected during that period in order to evaluate the effectiveness of the intervention on CLABSI rates, adherence rates, knowledge, contextual and behavioural influences, in the implementation of evidence-based CLABSI preventive practices in a medical ICU. Figure 3.2 demonstrates the periods of the study, and the data collection method used within each period.

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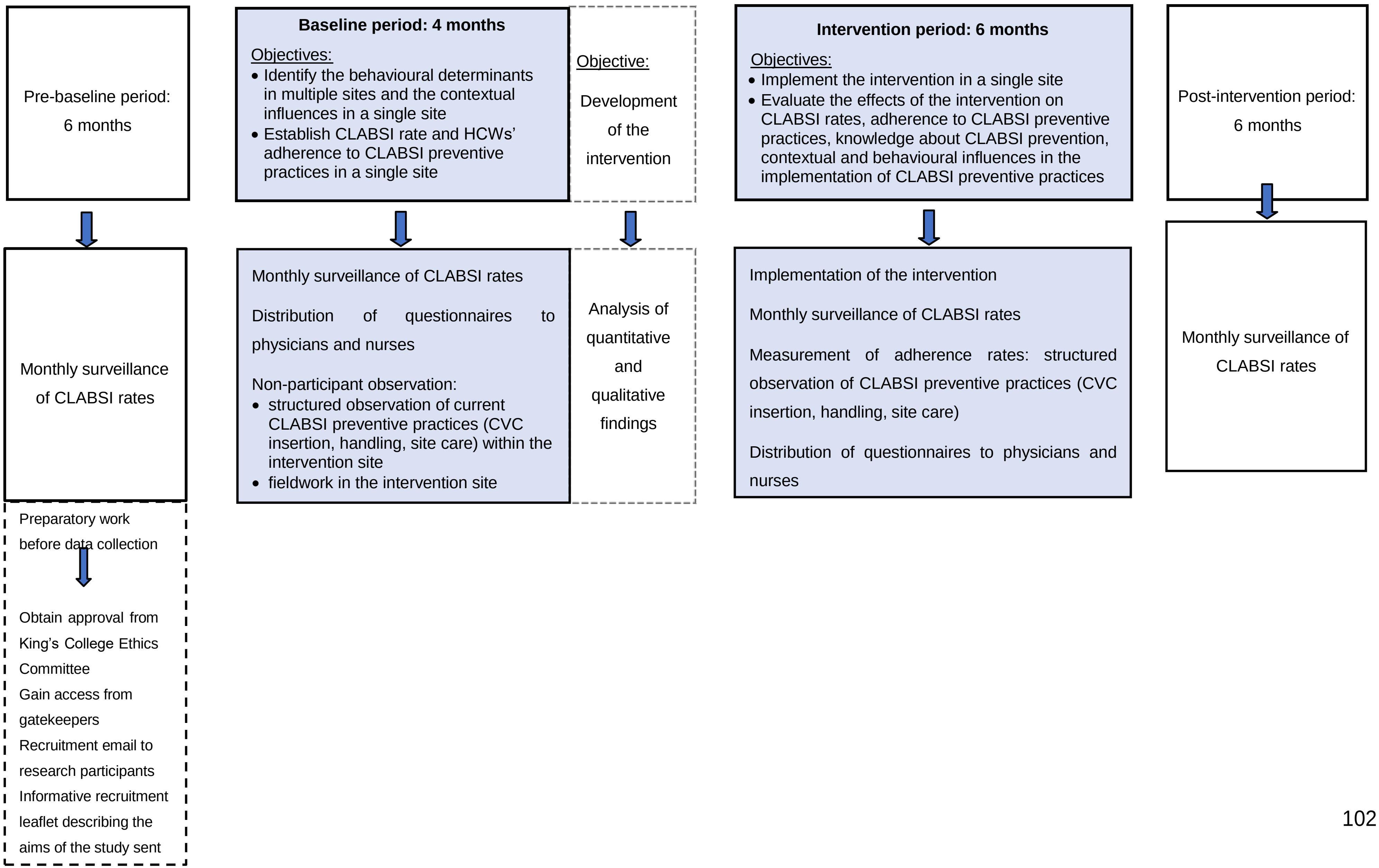
Figure 3.2: Research design of the study



3.5 Summary and conclusion

In summary, this chapter presents the theoretical model that guided the present research. The research question aims, and objectives of the study were formulated to address the gaps identified in the literature, in order to add to the knowledge base. Finally, the design of the research across the four periods of the study was discussed. The next chapter proceeds to discuss the methods used for data collection in the baseline period of the research, followed by a description of the data analysis stage of the study.

PART ONE: BASELINE ASSESSMENT: METHODS AND RESULTS

CHAPTER 4: Assessment of baseline behavioural and contextual influences related to CLABSI prevention - rationale, aims and methods

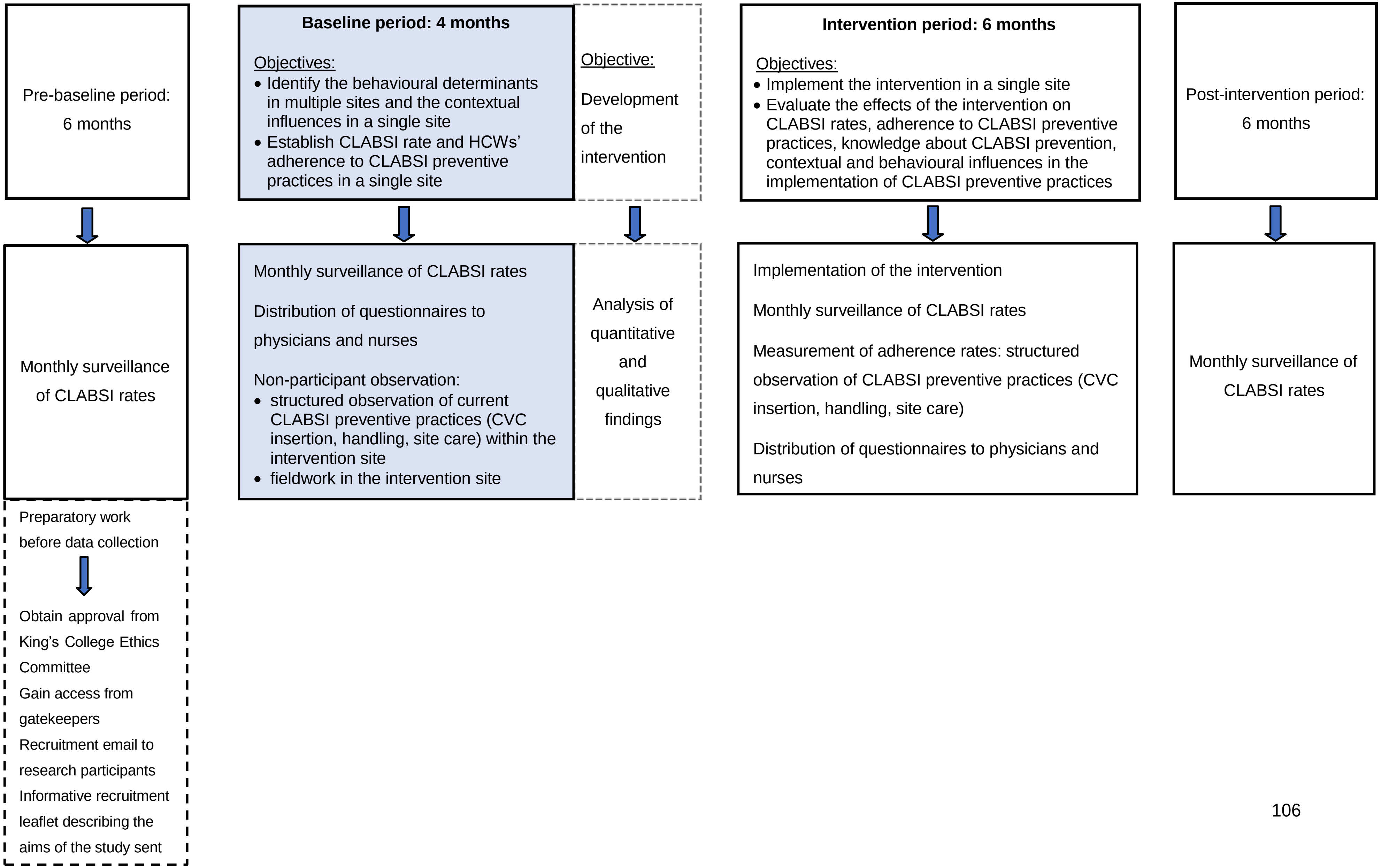
4.1 Introduction

This chapter describes the baseline period of the study. The design employed in the baseline assessment is presented in Figure 4.1. During this period baseline behavioural and contextual influences related to CLABSI prevention were identified. The assessment of the context was considered essential prior to the development of the study's intervention. Firstly, a lack of such baseline data may limit understanding of the existing conditions related to infection control and prevention within the research context. Secondly, the ability to obtain adequate information about the extent of improvement, after the intervention has taken place, is also limited (Pronovost et al. 2008c). Details about the conduct of the baseline assessment are described in the following sections. The choice of a mixed-method approach is examined, followed by a description of both quantitative and qualitative data collection methods to establish baseline information. A description of the research setting, and sample follows, while the principles used to obtain access and ethical approval are also discussed. Data analysis procedures, along with issues of validity and reliability, are also presented.

4.2 Aims and objectives of the baseline period

In light of the gaps in knowledge, as identified in the literature review (Chapter 2), the baseline assessment aimed to identify the contextual elements (for example, local circumstances, policies, organisational characteristics, resources, knowledge, training, motivation and skills) which influence implementation of evidence-based CLABSI preventive measures.

Figure 4.1: Research design used in baseline period



The specific objectives of the baseline assessment were to:

- Identify the behavioural determinants (self-efficacy, behaviour intention, attitudes, social influence, and motivation) of healthcare workers (HCWs) affecting the implementation of CLABSI preventive practices in multiple sites;
- Identify contextual influences on the implementation of CLABSI preventive practices in a single site;
- Establish health care workers' (HCWs) adherence to evidence-based CLABSI preventive practices in a single site.

4.3 Design

The baseline assessment used quantitative and qualitative approaches to address its aims. Although infection control has historically employed quantitative research linked with rigour, objectivity, generalisation and increased credibility, the use of qualitative methods was considered an appropriate data collection method, as infection prevention in ICUs involves largely human interactions in a complex and demanding environment (Forman et al. 2008). Additionally, qualitative methods can reveal insights about organisational and cultural features of the ICU setting, which enhance knowledge of social processes related to infection control and prevention (Sinuff et al. 2007). Self-reported questionnaires and non-participant observation of the field work were used to collect data in the baseline assessment. The following section describes the research sites recruited in the baseline period.

4.4 Research sites

There was only one ICU intervention site, hereafter referred to as the intervention site. However, the baseline, self-reported questionnaires were distributed to four

ICUs in total, in accordance with the theory's instructions (Theory of Reasoned Action, Francis et al. 2004) because a sample size of at least 80 participants was required for the psychometric testing and the development of the questionnaire. Given that the number of HCWs at the intervention site was less than 80, for the purposes of developing the questionnaire, a larger sample was required, and questionnaires were distributed at another three ICUs (which were not in the hospital in which the researcher worked), located in Athens, Greece. Figure 4.2 indicates the research sites used in the baseline assessment following relevant approval from the King's College Ethics Committee.

Figure 4.2: Research sites used in baseline assessment

HOSPITAL A	**ICU 1: intervention site**
	ICU 2
HOSPITAL B	**ICU 3**
HOSPITAL C	**ICU 4**

Hospital A was a 710-bed tertiary hospital specialising in chest and thoracic diseases. It comprised two ICUs: the intervention site (ICU 1), a teaching 10-bed medical ICU, and ICU 2, a 7-bed respiratory ICU. Hospital B was a 760-bed tertiary hospital, which comprised an 8-bed general ICU (ICU 3). ICU 4 was an 8-bed general ICU, located in a 300-bed hospital (Hospital C). These hospitals were selected because they represented some of the largest hospitals in Athens, Greece in terms of range of medical specialties; number of ICU beds; and number of critical care personnel.

4.5 Research participants recruited for the questionnaire development

A purposive sample of 177 critical care physicians and nurses was recruited. Purposive sampling has been criticised for the difficulty which it presents to the researcher when evaluating whether or not a sample is representative (Grove et al. 2012). However, the above sample was considered typical of Greek critical care personnel, for the purpose of identifying the behavioural determinants that could influence the implementation of evidence-based CLABSI preventive measures. Figure 4.3 presents the number of physicians and nurses in each participating ICU. One hundred questionnaires were distributed to critical care nurses and 77 questionnaires to critical care physicians; 144 questionnaires were returned, giving a response rate of 81%. There was an 88% per cent response rate from critical care nurses (n=88) and 73% response rate from critical care physicians (n=56). The sample of physicians fell short of three participants to satisfy the criterion set for multiple regression analysis which requires a total of 80 respondents (Francis et al. 2004). Implications of this are discussed in the study limitations (Chapter 8).

4.6 Data collection methods during baseline assessment

A six-part, self-reported questionnaire was developed to collect baseline data in the present study. The individual parts of the questionnaire are presented in Table Parts A, B, C, D and E of the questionnaire were administered to participants at the intervention site (n=37). Parts B, C and D were also administered to critical physicians and nurses (n=140) employed in ICUs 2, 3 and 4 (Figure 4.3). Demographic characteristics (Part F) were assessed for all participants.

Figure 4.3: Number of critical care physicians and nurses in each participating ICU for questionnaire development

HOSPITAL A	**ICU 1: intervention site** nurses (n=20) physicians (n=17)
	ICU 2: nurses (n=23) physicians (n=12)
HOSPITAL B	**ICU 3:** nurses (n=25) physicians (n=24)
HOSPITAL C	**ICU 4:** nurses (n=32) physicians (n=24)

Part A: Knowledge test

A multiple-choice knowledge test was considered the most appropriate way to assess knowledge about CLABSI preventive guidelines. A ten-question, self-completed test (Labeau et al. 2009) was distributed to HCWs at the intervention site (n=37) in order to assess their level of knowledge about CLABSI prevention, at the baseline. The abovementioned knowledge test has been previously administered and validated within a large sample of European critical care nurses (n=3200), including Greek ICU nurses (Labeau et al. 2009). The content of the test was based on US Center for Disease Control and Prevention (CDC) central venous catheter-related infection prevention guidelines (O'Grady et al. 2011).

Table 4.1: Parts of survey questionnaire used in baseline assessment

Questionnaire part	Description	Distributed to
Part A: Knowledge test (Labeau et al. 2009) Translated from English language to Greek	Multiple-choice knowledge test (Labeau et al. 2009). Test comprises 10 items; each correct answer is given 1 point; a wrong answer was not scored negatively; 10 points and 0 points were the maximal and minimal score respectively.	**HCWs in intervention site**
Part B: Self-efficacy Newly developed scale, developed in Greek language	Self-efficacy scale (Bandura 1986) described critical care physicians' and nurses' capability to perform the evidence-based preventive measures relating to CLABSIs even though certain barriers exist. The scale included 11 items rated using a 7-point Likert type scale (1 = totally disagree to 7 = totally agree). Possible scores range from 11 to 77; the higher the score, the greater the capability of critical care personnel to apply CLABSI preventive measures.	**All participants**
Part C: Behavioural Intention Newly developed scale, developed in Greek language	Intention performance scale was based on evidence-based guidelines regarding insertion, handling and care of a central line. Physicians' and nurses' intention performance scale included 10 and 5 items, respectively. Items rated using a 7-point Likert type scale (1 = never to 4 = half the time to 7 = every time). Possible scores range from 5 to 35 for nurses and 10 to 70 for physicians; the higher the score, the greater the intention performance reported by physicians and nurses.	
Part D: Attitudinal and social influence scale Newly developed scale, developed in Greek language	Attitude and social influence scale (Fishbein & Ajzen 1975) included 28 items, rated using a 7-point Likert-type scale (1 = totally disagree to 7 = totally agree). Attitudinal scale (20 items) referred to critical care personnel's attitude toward evidence-based practices related to CLABSI prevention. Social influence scale (8 items) referred to critical care personnel's perception of social pressures to perform or not to perform evidence-based practices related to CLABSI prevention.	
Part E: Context Assessment Index (McCormack et al. 2002) Translated from English language to Greek using back-translation process	Context Assessment Index (CAI) (McCormack et al. 2009) assesses healthcare organisations' readiness to implement evidence by examining contextual factors namely, culture, leadership and evaluation of practice. CAI included 37 items rated using a 4-point Likert type scale (1 = totally agree, 2 = agree, 3 = disagree, 4 = totally disagree). Overall context score ranged from 0% (weak context) to 100% (strong context).	**HCWs in intervention site**
Part F: Demographic details	Age, experience, level of appointment, additional qualifications	**All participants**

The information covered in the knowledge test were:

- Aseptic Technique: types of disinfectant agents
- Types of Central Venous Catheter (CVC) site dressings
- Frequency of CVC dressing changes
- Antimicrobial ointment usage
- Frequency of intravenous tubing changes
- Frequency of intravenous Total Parenteral Nutrition tubing changes
- Frequency of CVC replacement
- Frequency of CVC replacement over guidewire
- Frequency of pressure transducers and tubing changes

Each correct answer was given a score of one point, while a wrong answer was not scored negatively. Thus, the maximum possible score was ten points, while the minimum possible score was zero points.

Part B: Self-efficacy scale

A review of the literature revealed that there was no existing data tool to assess CLABSI prevention-related self-efficacy. As a result of a thorough search of the literature, the most common barriers reported by critical care personnel in ICU settings to the implementation of evidence-based CLABSI preventive measures were selected. These were:

- Nursing shortage
- Lack of time
- Lack of knowledge related to CLABSI prevention
- Low standards of care
- Lack of support from senior managers
- Disagreement with evidence-based guidelines
- Lack of supplies
- Emergency procedure
- Low reinforcement form hospital managers
- Ineffective dissemination of infection control practices
- Lack of in-service education

The above barriers formed the items in the self-efficacy scale, including within the baseline survey questionnaire. An 11-item self-efficacy scale was distributed, to assess critical care physicians' and nurses' perceived ability to implement evidence-based practices when inserting or caring for a CVC, respectively, regardless of the existing barriers. Each participant was asked to respond to each item according to how confident he/she would be in his/her ability to implement the CLABSI evidence-based practices related to CLABSI prevention on a seven-point scale, from 1 ('strongly disagree') to 7 ('strongly agree'), yielding a total score ranging from 11 to 77. The final score was computed by calculating the mean of all 11 self-efficacy scores. The final self-efficacy score scores ranged from 1 to 7, with low scores indicating low self-efficacy and higher scores indicating high perceived self-efficacy.

Part C: Measures of the components of the Theory of Reasoned Action: intention to implement the evidence-based CLABSI preventive practices

Behavioural intention to implement the evidence-based CLABSI preventive practices, attitudes and social influence scales were developed in strict adherence to instructions by Ajzen and Fishbein (1980), Francis et al. (2004), and Montano and Kasprzyk (2008).

Intention performance was applied to obtain a measure of behavior intention (implementation of evidence-based CLABSI preventive practices). Participants were asked about the extent to which they intended to implement each of the evidence-based practices whenever they inserted (in the case of physicians) or cared for (in the case of nurses) a CVC. Two separate scales were developed; one for physicians and one for nurses. The 'behaviour intention' scale for physicians consisted of ten items, whilst the corresponding scale for nurses consisted of five items. The strength of an 'intention statement' was rated on a seven-point Likert-type scale, ranging from 1 (never), 4 (half the time) to 7 (every time). The higher the scores, the stronger the intentions to perform each of the evidence-based CLABSI preventive practices. The intention performance score ranged from 10 to 70 for physicians and from 5 to 35 for nurses.

Part D: Measures of the components of the Theory of Reasoned Action: attitude and subjective norm

Both direct and indirect measures of the above variables are recommended, when using the Theory of Reasoned Action to identify the specific beliefs that contribute most to attitudes and subjective norms and to design an effective behaviour-change intervention. This study therefore assessed, both directly and indirectly, the attitude and subjective norm.

Direct measurement of attitude and subjective norm

A direct measure of physicians' and nurses' attitudes toward performing the behaviour was obtained using four semantic differential scale items, namely 'easy practice/difficult practice', 'important practice/unimportant practice', 'unnecessary practice/necessary practice' and 'good practice/bad practice'. Each adjective pair was placed on opposite ends of a seven-point Likert-type scale ranging from 1 to 7. Higher scores indicate that respondents believe that implementing evidence-based CLABSI preventive measures is easy, important, necessary and good practice.

A direct measure of subjective norm was assessed by using three single items: ‘Colleagues whose opinion I value think that I should not implement....’, ‘Colleagues whose opinions I value would approve of my implementing....’ and ‘It is expected of me that I implement....’. Respondents’ subjective norm was assessed on a seven-point Likert-type scale ranging from 1 (‘strongly disagree’) to 7 (‘strongly agree’). The higher the scores obtained, the stronger the perceived social influence to adhere to CLABSI evidence-based preventive measures.

Indirect measurement of attitude and subjective norm

Attitudes and subjective norms were also measured indirectly using corresponding beliefs. Ajzen and Fishbein (1980) introduced a method to elicit information about behavioural beliefs, outcome evaluations, normative beliefs and motivation to adhere. Typically, these beliefs (so-called ‘modal salient beliefs’) are obtained from a representative sample of the population. To determine participants’ salient beliefs, the authors recommended that researchers:

(1) conduct an elicitation study with open-ended questions to assess a sample’s behavioural and normative beliefs

(2) perform a content analysis to rank-order the beliefs, and

(3) determine the five to eight most salient beliefs.

For the purposes of developing the questionnaire and piloting its content, two ICUs within the hospital where the researcher worked, were employed. For that purpose, five open-ended questions (Table 4.2) were addressed to 52 critical care physicians and nurses (nurses n=31, physicians n=21). These nurses and physicians were employed in two ICUs other than the four research sites already described (Fig 4.4)

Figure 4.4: Number of critical care physicians and nurses in each participating ICU during baseline assessment

HOSPITAL A	**ICU 1: intervention site** nurses (n=20) physicians (n=17)
	ICU 2: nurses (n=23) physicians (n=12)
HOSPITAL B	**ICU 3:** nurses (n=25) physicians (n=24)
HOSPITAL C	**ICU 4:** nurses (n=32) physicians (n=24)
HOSPITAL D	**Pilot sites**
	ICU 5 and ICU 6 **nurses (n=31)** **physicians (n=52)**

Table 4.2: Open-ended questions to elicit behavioural and normative beliefs

Critical care physicians	Critical care nurses
1. What do you believe are the advantages of implementing evidence-based preventive practices during insertion of a CVC?	1. What do you believe are the advantages of implementing evidence-based preventive practices during care of a CVC?
2. What do you believe are the disadvantages of implementing evidence-based preventive practices during insertion of a CVC?	2. What do you believe are the disadvantages of implementing evidence-based preventive practices during care of a CVC?
3. Are there any individuals or groups who would approve of your implementing evidence-based preventive practices during insertion of a CVC?	3. Are there any individuals or groups who would approve of your implementing evidence-based preventive practices during care of a CVC?
4. Are there any individuals or groups who would disapprove of your implementing evidence-based preventive practices during insertion of a CVC?	4. Are there any individuals or groups who would disapprove of your implementing evidence-based preventive practices during care of a CVC?
5. Is there anything else you associate with implementing evidence-based practices during insertion of a CVC?	5. Is there anything else you associate with implementing evidence-based practices during care of a CVC?

Elicitation questions were consistent in relation to *action* (implementation), *target* (evidence-based guidelines to prevent CLABSI), *time* (any time) and *context* (during insertion and maintenance of a CVC) (Francis et al. 2004, Montano & Kasprzyk 2008). The participants were asked to provide two kinds of information. Firstly, they were asked to describe the positive and negative outcomes of implementing evidence-based practices during insertion (for physicians) or care (for nurses) of a CVC. Secondly, they were asked to describe any individuals or groups who might approve or disapprove of their performance of the above behaviour. The above responses were then content-analysed to identify relevant outcomes of the behaviour and relevant social referents. To increase the validity of the analysis another expert nurse analysed participants' answers independently. Themes were listed in order, from most frequently reported to least frequently reported.

Once these were identified, appropriate items to enable indirect measurement of attitudes and subjective norms were identified. Behavioural beliefs were measured by eight items (items 5-10, 12, 13). Outcome evaluations were also measured by eight outcomes (items 14, 16, 18-19, 21, 23-24, 27). Each participant was asked to respond to each item on a seven-point scale ranging from 1 ('strongly disagree') to 7 ('strongly agree'). Normative beliefs (an indirect measure) were measured by three items (items 15, 22, 28) and motivation to adhere with referents was measured by two items (items 25, 26). Each participant was also asked to respond to each item on a seven-point scale ranging from 1 ('strongly disagree') to 7 ('strongly agree'). The operational definition, item definition, example items and measures within the Theory of Reasoned Action questionnaire are summarised in Appendix 3.

Scoring

Scoring was undertaken in accordance with the guidelines prescribed by Francis et al. (2004). The scoring key for the Theory of Reasoned Action questionnaire is summarised in Appendix 4. The scoring was performed as follows:

Behaviour intention: The overall intention items (Part C, items 1 to 5 for nurses and items 1 to 10 for physicians) were scored from 1 to 7 with the score on five items ranging from a minimum 5 to a maximum 35 and the score of ten items ranging from a minimum 10 to a maximum 70 for nurses and physicians respectively. The final score was obtained by calculating the mean of all five and ten intention items and ranged from 1 to 7. Low behaviour intention scores were indicated by low scores and high behaviour intention by high scores.

Attitude: The four direct attitude items (Part D, 1 to 4) were scored from 1 to 7, yielding a total score ranging from a minimum of 4 to a maximum of 28. The final score was computed by calculating the mean of all four direct attitude scores. The final direct attitude scores ranged from 1 to 7, with low scores showing poor attitude and higher scores showing positive attitude.

Behavioural belief items were similarly scored from 1 to 7. The outcome evaluation items were scored from -3 to +3, following a recoding process with the final scores ranging from -24 to +24 (scores in the negative showed a poor outcome evaluation and those in the positive showed a good outcome evaluation). The total indirect attitude score was obtained by multiplying each behavioural belief item score by the corresponding outcome evaluation item score. All the joint behavioural belief and outcome belief scores were added together to obtain an indirect attitude score which ranged from -168 to +168.

Subjective norm: The three direct subjective norm items (Part D, 11, 17, 20) were scored from 1 to 7, yielding a total score ranging from a minimum of 3 to a maximum of 21. The final score was computed by calculating the mean of all three direct attitude scores. The final direct attitude scores ranged from 1 to 7, with low scores showing poor attitude and higher scores showing positive attitude.

Normative belief items were scored from -3 to +3. The ‘motivation to comply’ items were scored from 1 to 7, with the final scores ranging from 2 to 14. The total indirect subjective norms score was obtained by multiplying each normative belief item score by the corresponding ‘motivation to comply’ item score. The final indirect subjective norms scores ranged from -42 to +42.

Part E: Context Assessment Index

The Context Assessment Index (CAI), developed by McCormack et al. (2002), was used to assess the context in the intervention site. It aimed to assess HCWs’ (n=37) perceptions about the readiness to utilise evidence in their working environment. Assessment of context is acknowledged as playing an important role in better understanding the links between context and implementation of evidence-based practices (Meijers et al. 2006). CAI assesses three elements: culture, leadership and evaluation of practices. Each element corresponds to potential areas for assessment along a continuum from ‘weak’ to ‘strong’ (Table 4.3). For an effective culture that is receptive to change and has person-centered ways of working, the three elements all need to be ‘strong’ (McCormack & Wright. 2009).

Table 4.3: Areas for assessment for context, culture, leadership and evaluation of practices

Continuum

Elements	Weak indicators	Strong indicators
Context	• Lack of clarity concerning boundaries • Lack of appropriateness and transparency • Lack of power and authority • Not receptive to change	• Boundaries clearly defined (physical, social, cultural and structural) • Appropriate and transparent decision-making processes • Power and authority understood • Receptiveness to change
Culture	• Unclear values and beliefs • Low regards for individuals • Lack of consistency	• Able to define culture in terms of prevailing values/beliefs • Values individual staff and clients • Consistency of individuals' role/experience to value: ➢ Relationships with others ➢ Team working ➢ Power and authority ➢ Rewards/recognition
Leadership	• Traditional, command and control leadership • Lack of role clarity • Lack of teamwork • Didactic approaches to teaching/learning/managing	• Transformational leadership • Role clarity • Effective teamwork • Enabling/empowering approach to teaching/learning/managing
Evaluation	• Absence of any form of feedback and information • Narrow use of performance information sources • Evaluations rely on single rather than multiple methods • Poor organisational structure	• Feedback on individual, team and systems • Use of multiple sources of information on performance • Use of multiple methods, clinical, performance and experience • Effective organisational structure

Reprinted from *Using the Context Assessment Index (CAI) in practice: facilitating consciousness raising for practice development* by McCormack, B. & Wright J. 2009. Newtownabbey, Co. Antrim: University of Ulster.

The CAI comprises 37 items: the culture sub-scale (16 items), leadership sub-scale (7 items) and evaluation sub-scale (14 items). Items in CAI are rated on a 4-point Likert-type scale ranging from 1 ('strongly agree') to 4 ('strongly disagree'). CAI items were subsequently scored from 1 ('strongly disagree') to 4 ('strongly agree'), following a reverse process to allow similar interpretation to the scores from the Theory of Reasoned Action and self-efficacy scales. The scoring of CAI was based on the authors' (McCormack et al. 2002) instructions. The total score for each sub-scale was calculated by summing the item scores and then multiplying (weighting) these total sub-scale scores for culture, leadership and evaluation elements by 1.5625, 3.57 and 1.78 respectively to produce a score in the range 25% to 100% (from weak to strong context). The total CAI score (%) is calculated by summing the three weighted sub-scale scores (%) and dividing by 3. The higher the score, the stronger the context.

Part F: Demographics of participants

The last part of the baseline survey questionnaire consisted of biographical details of the participants, in order to establish their professional profile. Information about length of ICU working experience, age, level of appointment, graduate and postgraduate educational qualifications were included. At the end of Part F, a blank space was left for participants to add any further information relevant to the topic under investigation. The English and Greek version of the study's questionnaire is included in Appendices 5 and 6.

4.6.1 Translation of the scales

The self-efficacy and Theory of Reasoned Action questionnaires were developed in the Greek language and translated into English by the researcher. The knowledge test (Part A) has been published in English (Labeau et al. 2009) and was also translated into Greek by the researcher. A two-step approach was employed for the translation of the CAI questionnaire (Part E). Firstly, according to Brislin's (1970) model, two bilingual experts were employed. One translated the questionnaire from English to Greek and a second blindly back-translated it to English. The combination of translation and back-translation avoids the problems inherent in translation and ensures users' understanding of the questionnaires (Brislin 1970). Secondly, a panel of three experts in critical care nursing practice and in the field of academia (Nursing School, University of Athens, Greece) assessed the face validity of the translated questionnaire. Although there are aspects of validity of greater importance than face validity, it is still useful because the willingness of participants to complete a questionnaire is related to their perception that the questionnaire measures the content that they agreed to provide (Grove et al. 2012). The panel of experts suggested minor changes regarding the Greek wording of the CAI. For example, the word *organisation* was replaced by the word *ICU* in order for participants to provide their views in relation to their immediate work environment, and not to the hospital in which they were employed. Moreover, the author of the CAI (McCormack et al. 2002) was contacted in order to ensure that any modification made reflected the intended meaning of the tool.

4.6.2 Structured observation

Adherence to CLABSI preventive practices was assessed through a quantitative method by direct observation of HCWs in the intervention site. As in some other European countries (e.g. Spain) surveillance of CLABSI in ICU settings is not mandatory in Greece. Therefore, the intervention site was purposively selected because it had had continuous surveillance of CLABSI in place since 2012. Thus, research became feasible in terms of CLABSI measurement before and after the intervention.

CLABSI evidence-based preventive practices were observed at the bedside by the researcher through using a structured checklist. Structured observation enabled the researcher to identify the staff's adherence to CLABSI preventive practices, and also to provide data about the actual practices performed by HCWs in their context, rather than relying on their self-reporting about these practices. Direct observation has been recognised as the 'gold standard', compared with self-reported adherence; however, it has received some criticism due to the effect of the presence of observers (the Hawthorne effect) on the validity of the findings

(Bowling 2016; Gould et al. 2017).

Observed practices included: CVC insertion (n=32), CVC handling (n=79) and CVC site care (n=18). The observation period lasted four months (baseline period). Observations took place during early and late shifts (8-hour shift), weekends excluded. CVC insertion was observed every time a new central catheter was inserted. CVC handling was observed at the times when most of medications were administered through the CVC. CVC site care was observed according to the date of CVC dressing replacement (when indicated and at least weekly). Table 4.4 summarises the process for observing the implementation of CLABSI preventive practices. Three separate checklists were developed according to the latest CLABSI prevention guidelines (O'Grady et al. 2011) (See, Appendix 7). Observation was undertaken at the bedside and assessment was recorded as a Yes/No choice within each checklist. At the end of each checklist there was a separate section for comments written by the researcher, as it was necessary to record any contextual influence relevant to the observed practice – for example, lack of supplies or equipment (Bowling 2016). The advantage of using previously used and validated observation checklists is that this enables the generation of data that can be compared to similar findings from previous studies (Pronovost et al. 2008c). HCWs were not aware in advance about the date and time schedule of observation periods.

Observation of all practices related to CLABSI prevention is a challenging process in terms of resources, and this was acknowledged by previous studies, which have not assessed adherence to CLABSI practices prior to the beginning of an intervention (Pronovost et al. 2006). Given that (a) CLABSI guidelines recommend the implementation of all evidence-based measures if CLABSI incidence is to be reduced, and (b) the aim of the baseline assessment was to identify the pre-implementation conditions related to CLABSI practices, it was decided that all practices related to CLABSI prevention should be observed.

Table 4.4: Process for observing the implementation of CLABSI preventive practices

CVC practices	Who was observed	Frequency of observations	Observed practice*
Insertion of a CVC	Physicians	Every time a new CVC was inserted. CVC insertion was observed during early and late shifts, weekends excluded.	**Hand hygiene** **Maximal sterile barriers:** a. sterile gown b. cap c. mask d. sterile gloves e. large sterile drape **Skin preparation:** CHX 2% or alcohol or povidone or other **Optimal site selection:** avoid femoral vein **Daily** review of CVC necessity
Handling of a CVC: ● Administration of IV medication and blood ● Disconnection and reconnection of CVC lumens, when a patient was transported out of the ICU for diagnostic examinations ● Blood withdrawal	Nurses	CVC handling was observed during two shifts per week (early or late), weekends excluded. Selection of the time of medication administration during early and late shift: 8am-12pm and 16.00pm- 20.00pm.	Hand hygiene Use of clean gloves Apply Aseptic Non-Touch Technique (ANTT) prior to accessing the CVC Scrub the hub Access only with sterile IV devices
CVC site care	Nurses	CVC site care was observed during two early shifts per week.	Hand hygiene Use of clean gloves/sterile gloves Skin disinfection Application of a sterile dressing: transparent or gauze Sterile technique maintained

* According to CDC's CLABSI preventive guidelines (O'Grady et al. 2011)

4.6.3 Measurement of baseline adherence to CLABSI preventive practices in intervention site

Adherence rates for each CLABSI practice were calculated by dividing the number of adhered-to practices (numerator) by the total number of CVC practices (denominator) and multiplying the result by 100 (Table 4.5). The target adherence rate was 100%.

Table 4.5: Calculation of measurement of CLABSI practices

Measurement	Calculation
Adherence to all evidence-based measures during CVC **insertion**	$\dfrac{\text{Number of CVC insertions in which all evidence-based measures are implemented}}{\text{Number of observed CVC insertions}} \times 100$
Adherence to all evidence-based measures during CVC **handling**	$\dfrac{\text{Number of CVC handlings in which all evidence-based measures are implemented}}{\text{Number of observed CVC handlings}} \times 100$
Adherence to all elements of CVC **site care**	$\dfrac{\text{Number of CVC site care instances in which all evidence-based measures are implemented}}{\text{Number of observed site care instances}} \times 100$

4.6.4 Reliability and validity

The reliability and validity of research instruments is a major criterion for assessing their quality, and an important consideration for any research project (Polit & Beck 2006). Reliability denotes the internal consistency of an instrument and is an indication of the extent of random error in the measurement method (Burns & Grove 2005, Polit & Beck 2006). Although all measurement techniques contain some random error, the less variation an instrument produces in repeated measurements the greater is its reliability (Polit & Beck 2006).

The reliability of the scales included in the survey questionnaire was calculated through both the test-retest method and Cronbach's alpha coefficient (Tables 4.6a, 4.6b).

Table 4.6a: Reliabilities of questionnaire scales in piloting testing for questionnaire development

Scales	Test-retest interclass correlation coefficient Physicians(n=14)/nurses(n=21)	Cronbach's Alpha correlation coefficient Physicians(n=14)/nurses(n=21)
Knowledge test	0.86*	N/A
Self-efficacy	0.89*	0.86
Behaviour intention	0.95 / 0.81*	0.41 / 0.76
Direct measures of:		
- attitudes	0.80*	0.52
- subjective norms	0.78*	0.83
Context Assessment Index	0.82**	0.94

* $p<0.001$ ** $p=0.003$

Table 4.6b: Reliabilities of study's questionnaire scales

Scales	Internal consistency Cronbach's alpha	
	Physicians (n=56)	Nurses (n=88)
Self-efficacy	0.90	0.87
Behaviour intention	0.71	0.60
Direct measures of:		
- attitudes	0.80	0.55
- subjective norms	0.54	0.48
Context Assessment Index	0.92	0.91

Test-retest procedure is usually applied in surveys to check the stability of single questions, by administering the same questions to individuals on two separate occasions (de Vaus 2014). Although this method has its limitations (difficulty in accessing the sample twice, and memory bias) (de Vaus 2014), the survey questionnaire was administered to the pilot sample (nurses, n=21 and physicians, n=14) twice at an interval of two weeks. The correlation between the answers on both occasions was then calculated. Additionally, Cronbach's alpha statistic was applied, as it is the most appropriate reliability measure for assessing the extent to which all items in a test measure the same concept, and thus it is connected to the inter-relatedness of the items within the test (Tavakol & Dennick 2011). According to McCrae et al. (2011), the two abovementioned methods could be combined to evaluate reliability, since a reliability coefficient and longitudinal stability based on one method should not be interpreted as equivalent to another calculated using a different technique.

The validity of the research instrument was assessed through two different dimensions, namely face validity and content validity (Grove et al. 2012). The knowledge test was a valid and reliable test (Labeau et al. 2009), which was based on CDC central venous catheter-related infection prevention guidelines. Moreover, it has been previously administered in a large population of critical care nurses (n=4802, response rate 70.2%) in 22 European countries, including Greece (Labeau et al. 2009). Content validity of the self-efficacy scale was assessed through review of the literature in relation to the reported barriers to implementation of CLABSI practices and through the expert panel's feedback. Content validity of the attitudinal and social influence scale was assessed through extensive preliminary work (an elicitation study), and for CAI content validity was assessed thorough cross-back translation and the expert panel's feedback.

4.6.5 Outcome measure & data collection in the intervention site

Continuous surveillance of CLABSI rates has been established in the intervention site since 2012. Standard laboratory methods were applied to identify all microorganisms/isolates. CLABSI rates have been monitored by reviewing the medical record of every patient who had positive blood culture on a daily basis by the existing infection control team at the intervention site. They collected data on the number of CLABSI and catheter days using CDCs definition (See, Appendix 8). CLABSI rates were expressed as episodes of CLABSI per 1000 catheter days, describing the total number of days that each patient had a central line in place. Data were submitted monthly to the ICU's central database.

Central line days, rather than patient days, were used as the denominator, since only patients with a central line are at risk of developing CLABSI. The National Health Safety Network (NHSN) emphasises that no matter how many central catheters or lumens each individual patient has, each such patient is counted as 'one catheter day' (The Joint Commission 2012). Patients' severity of disease (APACHE II), the number of patient days, catheter days, CVC utilisation ratio and the microbiology of CLABSIs were assessed, as these have been identified as risk factors for CLABSI occurrence (Tabah et al. 2012). Measurement of CLABSI rates is presented in table 4.7.

Table 4.7: Measurement of CLABSI rates

Measure	Calculation
CLABSI rate per 1000 central venous catheter-days	$\frac{\text{number of CLABSI cases}}{\text{total number of central venous catheter days}}$ X

Standard laboratory methods were applied to identify all microorganisms/ isolates in the intervention site (ICU 1). Collection methods for all data elements were the same in both phases of the study. Surveillance of CLABSI rates has been undertaken continuously since 2012 in the intervention site. Surveillance was conducted by one intensivist physician who was also certified as an infection preventionist. He reviewed monthly the medical record of every patient who had positive blood culture, and data were recorded to a web-based data entry system.

4.7 Pilot work

According to Polit and Beck (2006) a pilot study is a small-scale trial run of the study that enables the researcher to improve or assess the effectiveness of the project. In this case a pilot study was conducted to test the adequacy of the translation, and the relevance of each item to the objectives of the diagnostic phase of the study. The pilot study also tested the planned data collection procedures; for example, to ensure that the participants understood the items in the questionnaire in the same way and whether the instructions were clear. As Meadows (2003) has noted, these objectives are more likely to be accomplished if the instruments are piloted in a small but representative sample typical of the main data collection sample.

The content of the proposed questionnaire was evaluated by a pilot sample of 35 HCWs (nurses, n=21 and physicians, n=14) employed in two ICUs other than the research sites. The characteristics of the pilot sample were similar to those of the research participants, in terms of their educational background and years of experience in the ICU setting. The pilot sample were asked to provide feedback regarding the clarity of the questions through supplementary open-ended questions at the end of the questionnaire, and by commenting on any difficulty (e.g.

instructions, wording, format, length) that they might have encountered when completing it, as well as suggestions for improvement. Adjustments to wording were made at the respondents' suggestions. All items were found to be largely understandable. However, pilot participants noted that items in the self-efficacy scale and attitudinal and social influence scale of the questionnaire should be reworded in order to be clearer to respondents. For example, all items initially utilised the verbs '*insert or care",* as if they were addressed either to physicians or to nurses, implying that *insert* would refer to physicians' practice and *care* to nurses' practice. Such wording was reported by the pilot sample as being unclear; hence all items within the physicians' scales used the verb *insert,* while all items within the nurses' scales used the verb *care*. Additionally, in the attitudinal and social influence scale respondents suggested that the wording 'easy to do' be replaced by 'easy practice', as the former might imply lack of appropriate skills rather than ease in undertaking care of a central line. In the light of the above comments, the wording of the items in the abovementioned scales was modified to be clearer and concise.

Structured observation of the actual CLABSI prevention practices through the study's observation checklist was rehearsed more than once prior to the beginning of the baseline assessment. The content and format were piloted by the researcher on the critical care nurses of the two pilot ICUs. Following this, minor refinements of the checklists were made based on their feedback by the researcher. Finally, some of the items were further refined in order to be better understood in the Greek language. Additionally, the researcher rehearsed the observation of the above practices in order to become familiar with the related checklists. Overall, the participants welcomed the study, since the topic had never been previously explored within the Greek ICU population. The final questionnaire appeared to be readable, clear and capable of being completed in a timely manner.

4.8 Field work in intervention site at baseline

Observation is considered to be the closest to a 'gold standard' in qualitative research. It enables researchers to collect information in a systematic way, such as actions, behaviours, reactions and interactions (Bowling 2005). Observation of the setting allows the researcher to observe and describe a particular phenomenon in the real-world setting in which it occurs (Creswell et al. 2007, Bloomer et al. 2012). Although observation, as a data collection method, has other limitations, it does not depend upon participants' memory and knowledge or on the existence of thorough and complete documents, all of which include an element of risk of distortion and are subject to bias (Bowling 2016).

Field work was applied in the intervention site in order for the researcher to shed light on the obstacles that HCWs in the intervention site encounter when they implement CLABSI preventive measures. For that purpose, a non-participant observation technique was adopted by the researcher. A 40-hour complementary field work exercise was undertaken in order for the researcher to identify contextual elements that could hinder or facilitate HCWs in implementing CLABSI preventive practices. As the researcher did not want to accumulate an unmanageable amount of data, field work was restricted only to observation of aspects related to CLABSI prevention (Bloomer et al. 2013, Bowling 2016). Moreover, the researcher's background in critical care nursing has assisted her in the realistic assessment of the 'field', to remain focused on the research agenda and to collect accurate findings (Creswell et al. 2007, Bloomer et al. 2013). Nevertheless, a field work schedule was developed in order to guide the structure of the observation and to facilitate the observation of operations related only to CLABSI prevention. The observation schedule used during the baseline assessment is presented in Appendix 9.

The observation literature illustrates that the senses of listening, looking and feeling in the ICU environment provide valuable insights (Bowling 2016). Firstly, the researcher observed the layout of the intervention site, with the aim of identifying contextual barriers or facilitators related to the implementation of CLABSI prevention. The clinical setting (physical environment) was observed to assess whether the intervention site was equipped with the appropriate educational documents, supplies and equipment related to CLABSI prevention. Moreover, the researcher evaluated whether the layout of the ICU setting and the available equipment (e.g. access to hand hygiene antiseptic agents) facilitated the implementation of CLABSI preventive measures. Secondly, informal conversations were held with the staff during early and late shifts. These took the form of either a brief conversation (10-15 minutes) during nurses' breaks or longer discussions, with both physicians and nurses, at the unit's station. The ICU's nurse manager was also informally approached, while the medical director and the unit's team of physicians were collectively approached as soon as the morning handover had been completed. Their views, concerns or challenges with regard to CLABSI prevention were listened to and noted.

In practice, the researcher would typically walk through the ICU setting or stand in the background to observe and asking questions while recording her observations on the observational schedule document. At the end of each observation document was a separate section for comments, which was completed accordingly.

Additionally, field notes were taken, including (a) brief notes from HCWs' accounts, and (b) descriptions of any event that occurred while CLABSI preventive practices were being undertaken. Mental and/or jotted notes were taken throughout the informal discussions, as this was considered less likely to attract attention from the staff (Bloomer et al. 2017). All types of notes taken from the observational sessions were transferred to more detailed written text at the end of each day, as the deciphering of jotted notes can be a challenging task, and as days pass the meanings of exchanged accounts may be forgotten (Green & Thorogood 2005). An example of contemporaneous field notes is provided in Appendix 10.

The researcher adopted a non-participant observer role in the intervention site during the observation period. Non-participant observation has the advantage of the researcher remaining an independent outsider who can communicate and interact with the participants on his/her own initiative, without affecting the routine of daily practice (Bloomer et al. 2017). During the baseline assessment the researcher held the position of a critical care nurse in an ICU of a public hospital (not the intervention site) in Athens, Greece. Rapport with physicians and nurses was therefore established on a professional level (Bloomer et al. 2017). This factor was considered likely to be appreciated by the study participants, who felt able to comment on professional issues to the researcher.

The medical director of the ICU requested the researcher to wear 'scrubs', for infection control reasons, in a different colour in order to be distinguished from the rest of the staff. Nevertheless, the researcher minimised the risk of being native by maintaining clear role boundaries during data collection (Bloomer et al. 2012, Bloomer et al. 2017). Moreover, even though the researcher was wearing differently coloured scrubs, there was the possibility of being called upon, by those being observed, to act in a nursing capacity. However, it was agreed that the researcher would intervene only in case of emergency, and only in the absence of the attending physicians. The latter was dictated by the ethical principles of non-participant observation (Green & Thorogood 2005).

4.8.1 Methodological challenges

Although alterations in practices (the Hawthorne effect) of those being observed, as a consequence of them knowing that are being observed, has been well documented, this was not believed to be the case during baseline assessment for this study (Bowling 2016, Bloomer et al. 2017). The researcher stood at a distance from the bedside during observation, as the layout of the intervention site facilitated this. With regard to the comprehensiveness of observations, the researcher spent sufficient time in the field (during early and late shifts and at weekends) to ensure that the data collected were typical within the research setting. The credibility of collected data was also enhanced by observing both HCWs' practices and the working environment.

4.9 Ethical considerations

The baseline assessment was designed and conducted in as efficient and ethically sound a manner as possible, by adhering to the following ethical principles (Silverman 2010:54):

I. Voluntary participation and the right to withdraw
II. Protection of participants
III. Assessment of potential benefits and risks to participants
IV. Obtaining informed consent
V. Not doing harm.

A Hellenic National Research Ethics Committee has not yet been established. Therefore, ethical approval was obtained from the Ethics Committee of King's College, London, UK (CREC-PNM/13/14-78, June 2014). This enhanced the researcher's professional confidence, as a trained researcher with the support of a legitimate academic institution.

All research participants were explicitly informed about the purpose, methods and intended possible uses of the research, what their participation would involve, and the likely risks, if any, and benefits that could occur. The researcher informed the participants that their participation was voluntary, and that they had the right to withdraw from the research at any time without giving any reason, and with no penalty. Participants were assured that the study questionnaires distributed were anonymous, and it was also explained to them that the findings from the observations would remain confidential and that no other identifying data was collected from them. Notwithstanding this, it was made clear to the participants that if, during the observations, the researcher identified practices that could harm patients' safety, she was authorised, by the medical director of the intervention ICU, to report the incidents to the medical and nursing director of the research ICU. Moreover, participants were assured that all data was stored in a locked filing cabinet and on a password-protected computer using encryption and firewall protection. The above information was explicitly provided in written form (See, Appendix 11), while a separate consent form was signed by all participants (See, Appendix 12). Return of the questionnaire constituted the participants' consent to take part in the survey.

4.9.1 Gatekeepers

Once ethical approval from King's College was obtained (See, Appendix 13), a formal letter (See, Appendix 14) was sent to the relevant research and scientific advisory board of all participating hospitals in order to gain local access. In total five hospital approvals were gained; one for the requirements of the pilot study and four for the baseline period. Once formal local access agreements were in place, several informal access negotiations were established in order to ensure cooperation and access to the research participants (Polit & Beck 2006). For this purpose, the researcher personally contacted the medical and nursing directors of the research sites. The aim was twofold; firstly, to be introduced to them and to explain the main purpose of the study, by briefly describing how the research could benefit each hospital in preventing CLABSIs and HCAIs in general. Secondly, the researcher requested approval to access participants in each hospital. All medical and nursing directors were willing to participate in the research.

4.10 Data analysis

Data from the questionnaire survey and from structured observation were analysed using quantitative methods, including both descriptive and inferential statistics. Data were coded and analysed through the statistical package for social sciences (SPSS) (IBM Corporation. released 2012). The choice of statistics for data analysis was defined by the type of variables and data distribution (de Vaus 2014). Regular meetings with a local and the Faculty statistician were held during the data analysis process in order to clarify any uncertainty and to ensure that ethical procedures were applied.

4.10.1 Descriptive statistics

Nominal level data are expressed as absolute numbers and percentages, while continuous and ordinal level data are expressed as mean, standard deviation, median and interquartile range. Ordinal level data were treated in this way for better clarification and presentation, since they were variables with many categories (4-point and 7-point Likert-type scales). Demographics, individual items within the knowledge test, and adherence with CLABSI preventive measures were treated as nominal data.

4.10.2 Inferential statistics

The Kolmogorov-Smirnov test and graphs (histograms and normal Q-Q plots) were used to test the normality of the distribution of the continuous variables. Data were analysed by both parametric and non-parametric statistics. Total scores were calculated according to the following variables: self-efficacy, intention performance, attitude, subjective norms, behavioural beliefs and context assessment index. Scores relating to normative beliefs did not follow a normal distribution, while all the other scores did so. Independent t-tests or Mann-Whitney tests were used to assess the impact of dichotomous independent variables on total scores. Spearman's correlation coefficient (r_s) and Pearson's correlation coefficient (r) were used to measure the rank-order and linear association respectively between continuous variables. A correlation coefficient of 0 means there is no association, and a value of 1 means that there is a perfect association. Cohen (1988) has defined small, medium and large associations as follows: r=0.10 (small effect), r=.30 (medium effect), r=.50 (large effect). The behaviour intention scale score was modeled using linear regression. All independent variables were entered into the model simultaneously; the independent variables were working experience, post-qualification education, scores of self-efficacy, attitudes and subjective norms scale. The beta (slope) coefficient (non-standardised and standardised) standard error of beta, 95% confidence interval and probability value were calculated.

All tests of statistical significance were two-tailed, and p-values <0.05 were considered as statistically significant. A summary of data analysis is presented in table 4.8.

4.10.3 Analysis of the qualitative data

Qualitative data collected from field work were analysed using the thematic content analysis approach (Green & Thorogood 2005). This type of analysis reflected on the aims of the baseline assessment, which were to elicit from the staff what it meant to them to implement evidence-based CLABSI practices in their everyday work. The content of the accounts was thematically analysed, focusing on allowing the meanings to emerge through recurring common themes. A copy of each account was transferred to a blank A4 sheet. In the margin of each page a different colour was used to identify each theme. An example of the thematic content analysis is provided in Appendix 15.

Table 4.8: Data analysis summary

1.Baseline data	**Statistical test**	**Rationale**
Behavioural determinants		
Self-efficacy score, intention performance score, attitude score, behavioural beliefs score, subjective norms score differences between physicians and nurses	Student's t-test	To test for score differences between professional groups at baseline. Scores followed normal distribution
Normative beliefs score differences between physicians and nurses	Mann-Whitney	To test for score differences between professional groups at baseline. Scores did not follow normal distribution

Correlation between self-efficacy, intention performance score, attitudes, behavioural beliefs, subjective norms and normative beliefs scores for physicians and nurses	Spearman's rank correlation coefficient and Pearson's rank correlation coefficient	To determine if there was correlation between intention and self-efficacy, attitude, behavioural beliefs, subjective norms and normative beliefs
Relation between intention performance score (dependent variable) score and self-efficacy, attitudes, subjective norm scores, years of working experience and post graduate education (independent variables) for nurses and physicians	Linear regression analysis	To find the relationship between intention (dependent variable) and self-efficacy, attitudes, subjective norms, years of work experience and postgraduate education (independent variables).
Knowledge		
Knowledge scores differences between physicians and nurses' pre-intervention	Student's t-test	To test for knowledge score differences between professional groups at baseline. Scores followed normal distribution.
Knowledge score differences according to physicians' professional characteristics	Student's t-test	To test for knowledge score differences amongst physicians' professional characteristics. Scores followed normal distribution.
Knowledge score differences changes according to nurses' professional characteristics	Student's t-test	To test for knowledge score differences amongst nurses' professional characteristics. Scores followed normal distribution
Context		
Context, culture, leadership and evaluation of practices score differences between physicians and nurses	Student's t-test	To test for context and sub-scales scores differences between professional groups. Scores followed normal distribution.
2.Effectiveness of the intervention		
CLABSI incident density amongst the four study's periods	Sequential Bonferroni analysis	To test for pair-wise differences in CLABSI rates between the periods

Adherence rates		
Individual item changes for CVC insertion, CVC handling and CVC site care practices between baseline and intervention period	*Chi*-square test and Fisher's exact test	To compare the difference in proportions between pre and post intervention
Individual items differences between baseline and four periods over the intervention period	Cochran-Armitage trend score	To compare the difference in proportions between baseline and four periods over which observations of practices were observed during the intervention period
Knowledge		
Knowledge score for the total sample of critical care staff between baseline and 1st and 6th month post-intervention and between 1st and 6th month post-intervention	Student's t-test	To compare the difference in knowledge scores differences between unpaired groups baseline and intervention period and within intervention period. Scores followed normal distribution.
Context		
Context, culture, leadership and evaluation score differences between baseline and intervention period for the total sample of critical care staff and for physicians and nurses separately	Student's t-test	To compare the difference in CAI scores between unpaired groups baseline and intervention period. Scores followed normal distribution
Behavioural determinants		
Self-efficacy, attitude, behavioural beliefs, subjective norms and normative beliefs score differences for nurses and physicians between baseline and intervention period	Student's t-test Mann-Whitney	To compare the difference in behavioural determinants scores between unpaired groups baseline and intervention period

4.11 Summary and conclusion

This chapter has described the research methods and design of the questionnaire used to assess baseline behavioural and contextual influences relating to CLABSI prevention. A quantitative approach, using a self-reported questionnaire, was considered to be the most appropriate means of achieving the objectives for the baseline period of the present study. The design of the behavioural beliefs questionnaire was based on the Theory of Reasoned Action and self-efficacy model, explained in Chapter 3. It had six parts, three of which aimed to examine the constructs of the theoretical model underpinning the study. The first part was used to collect information on the knowledge of physicians and nurses in the intervention site about CLABSI prevention. The second, third and fourth parts assessed the theoretical model underpinning the study, while the fifth part was used to assess the context of the intervention site. The sixth part collected the demographic of participants in all ICUs. The questionnaire was reviewed by a panel of experts and was pilot-tested among critical care physicians and nurses. The findings from panel of experts indicated a high degree of validity; however, in pilot test Cronbach's alpha co-efficient of three scales was found from 0.48 to 0.55. The findings of the pilot test of the questionnaire indicated that the questionnaire could be successfully utilised in the baseline assessment. Three previously validated checklists were used to directly observe the implementation of CLABSI preventive practices in the intervention site. Observation was rehearsed prior to the beginning of the baseline assessment. The collection of data for the baseline assessment was undertaken between July 2014 and October 2014 and involved critical care physicians and nurses working in Athens, Greece.

The following chapter presents the findings of the baseline assessment. The results of the investigation of the behavioural beliefs of Greek critical care physicians and nurses in their implementation of CLABSI preventive measures are presented, based on the abovementioned questionnaire. Then, the results from the assessment of knowledge and context in the intervention site and the findings from the analysis of informal discussions with nurses and physicians in the intervention site are also presented.

CHAPTER 5: Results of baseline assessment

5.1 Results from self-efficacy and Theory of Reasoned Action

The objectives of the baseline period of the study were to:

- Identify the behavioural determinants (self-efficacy, behavior intention, attitudes, social influence, and motivation) of HCWs toward CLABSI prevention in multiple sites;
- Identify contextual influences on the implementation of CLABSI preventive practices in a single site;
- Establish CLABSI levels and HCWs' adherence to evidence-based CLABSI preventive practices in a single site.

The first objective of the study was to assess the behavioural factors related to CLABSI prevention. The Theory of Reasoned Action (Fishbein & Ajzen 1975), which directs attention to behaviours intentions, attitudes and subjective norms, and the theory of self-efficacy (Bandura 1986) were used to identify critical care physicians' and nurses' behavioural determinants that motivate them to implement evidence-based CLABSI preventive measures. Participants completed a questionnaire measuring behaviour intention, attitude, subjective norms and self-efficacy. The questionnaire was distributed at the baseline period to critical care physicians and nurses employed in four ICUs within three large public hospitals in Athens, Greece. This chapter profiles the sample of physicians and nurses by their demographic and professional characteristics. The chapter also reports the results related to participants' self-efficacy, and their behaviour intentions, attitudes, subjective norms, behavioural and normative beliefs with regard to CLABSI prevention.

5.1.1 Participants' demographic characteristics

Questionnaires were distributed to 177 (n=177) physicians and nurses working throughout three general hospitals in Athens, Greece. The participants consisted of 77 critical care physicians and 100 critical care nurses. A total number of 144 participants (n=144) returned completed questionnaires, representing a response rate of 81%.

The demographic characteristics of the respondents are presented in Table 5.1. The mean age of the physicians was 44.1 years (SD=7.9 years) and of the nurses 37.7 years (SD=7.1 years). The majority of respondents were female (n=97, 67%). The mean length of ICU experience for both groups was six years. Sixty percent of the physicians specialised in intensive care medicine, while only 21% of the nurses held a qualification in critical care nursing.

Table 5.1: Demographic characteristics of 144 participants recruited at baseline period

	Baseline period	
	Physicians (n=56) N (%)	**Nurses (n=88) N (%)**
Gender (%)		
Female	31 (55.4)	66 (77.6)
Male	25 (44.6)	19 (22.4)
Age *(years), mean (SD)*	44.1 (7.9)	37.7 (7.1)
ITU work experience *(years), median (IQR)*	6.0 (1.0 - 15.0)	6.5 (3.0 - 14.8)
Appointment level *for physicians*		
Consultant	13 (23.6)	
Resident	23 (41.8)	
Fellow	19 (34.5)	
Appointment level *for nurses*		
Nursing manager-Deputy manager		2 (2.4)
Staff nurse		84 (97.6)
Post academic qualifications for physicians		
Medical specialty	13 (23.2)	
Specialty in critical care medicine	33 (58.9)	
MSc	9 (16.1)	
PhD	24 (42.9)	
Post academic qualifications for nurses		
Specialty in medical/surgical nursing		19 (21.6)
Specialty in critical care nursing		26 (29.5)
MSc		19 (21.6)
PhD		7 (8.0)

5.1.2 Self-efficacy scale

All participants were asked to rate themselves on an 11-item, seven-point Likert-type scale, ranging from 1 (‘strongly disagree’) to 7 (‘strongly agree’), describing how confident he/she felt to implement the evidence-based CLABSI preventive measures, regardless of any existing barriers. Descriptive statistics for items in the self-efficacy scale (in descending order according to mean for physicians and nurses) are provided in Appendix 16.

Boxes 5.1 and 5.2 provide examples of item statements from the self-efficacy scale, for physicians and nurses respectively. The mean score was 4.5 (SD=1.5) for physicians and 4.8 (SD=1.1) for nurses, compared with a possible range from 1 to 7. The overall self-efficacy for physicians and nurses was above the mid-point of 4.0, suggesting that both professional groups reported moderate self-efficacy. The scores ranged from 2.8 to 5.7 for physicians and 3.0 to 5.6 for nurses, indicating that there were both physicians and nurses who were not confident in their ability to implement the evidence-based CLABSI preventive measures and to overcome certain barriers. Adherence to CLABSI preventive measures was influenced by lack of supplies, as this factor was scored lowest by both professional groups, indicating that the question of adequacy of resources plays an important role in the implementation of best practices.

Box 5.1: Example of item statement in self-efficacy scale for physicians

I can manage to perform all infection control measures every time I *insert* a central line in the ICU where I work, even if some colleagues may not know about evidence-based guidelines on CLABSI prevention.

Box 5.2: Example of item statement in self-efficacy scale for nurses

I can manage to perform all infection control measures every time I *handle or care for* a central line, even if nursing staffing is low.

5.1.3 Theory of Reasoned Action questionnaire: behaviour intention scale

Physicians and nurses were asked to rate a 10-item and 5-item respectively, with each item rated on a seven-point Likert-type scale ranging from 1 (never), through 4 (half of the time) to 7 (every time). The scale describes the extent to which physicians and nurses implement each of the evidence-based measures every time they insert or care for a CVC. Behaviour intention score could range from 10 to 70 for physicians and from 5 to 35 for nurses. Each item in the behaviour intention scale was ranked in descending order according to the mean for physicians and nurses and are presented in Appendix 17.

Boxes 5.3 and 5.4 provide examples of an item statement from the behaviour intention scale, for physicians and nurses respectively. Overall, both professional groups reported that they would adhere to all CLABSI preventive measures nearly every time. The mean score was 6.1 (SD=0.7) for physicians and 6.3 (SD=0.7) for nurses (p=0.027). Selection of the subclavian site to insert a CVC was less frequently implemented among the physicians (mean 4.7, SD 1.3) than the nurses (mean, SD)

Box 5.3: Example of item statement from the behaviour intention scale for physicians

How often do you wear sterile gloves during insertion of a central line?						
1	2	3	4	5	6	7
never			half the time			every time

Box 5.4: Example of item statement from the behaviour intention scale for nurses

How often do you wash or disinfect your hands before handling a central line?						
1	2	3	4	5	6	7
never			half the time			every time

5.1.4 Theory of Reasoned Action questionnaire: attitudinal scale

All participants were asked to rate themselves on a four-item semantic differential scale – for example, *easy practice-difficult practice*. Participants had to answer each item on a seven-point Likert-type scale ranging from 1 (‘strongly disagree’) to 7 (‘strongly agree’), yielding a potential total score from a minimum of 4 to a maximum of 28. Items described the participants’ overall attitude towards implementing the evidence-based CLABSI preventive measures. Each item in the attitudinal scale was ranked in descending order according to the mean for physicians and nurses and are presented in Appendix 18.

Boxes 5.5 and 5.6 provide examples of item statements in the attitudinal scale, for physicians and nurses respectively. The mean score of the attitude scale for physicians was 6.0 (SD=1.4), while for nurses it was 6.2 (SD=0.9). The overall attitude of the respondents was higher than the mid-point (=4.0), suggesting that both professional groups believed that implementing the evidence-based CLABSI preventive measures is a positive practice.

Box 5.5: Example of item statement from the attitudinal scale for physicians

Overall, I think that implementing evidence-based measures during insertion of a central line in order to prevent CLABSIs is: Easy practice 1 2 3 4 5 6 7 Difficult practice

Box 5.6: Example of item statement from the attitudinal scale for nurses

Overall, I think that implementing evidence-based measures during handling or care of a central line in order to prevent CLABSIs is: Important practice 1 2 3 4 5 6 7 Not important practice

5.1.5 Theory of Reasoned Action questionnaire: behavioural belief scale

All participants were asked to rate themselves on a 16-item, seven-point Likert-type scale ranging from 1 ('strongly disagree') to 7 ('strongly agree'). The score ranged from -168 to +168. Scoring of the behavioural belief items is described in Chapter 4, *Part D*, page 119. The items described the participants' beliefs about the likelihood that implementation of the evidence-based CLABSI preventive measures would result in certain outcomes. Descriptive statistics for each item in the behavioural beliefs scale ranked in descending order according to the mean for physicians and nurses and are presented in Appendix 19.

Boxes 5.7 and 5.8 demonstrate examples of item statements from the behavioural belief scale, for physicians and nurses respectively. Physicians scored higher in the behavioural belief scale (mean=113 SD= 27.4) compared with nurses (mean=96.7 SD=71.4). This difference was statistically significant t (142) =3.47, p=0.001. Both physicians and nurses appeared to be convinced of the necessity of implementing CLABSI evidence-based measures.

Box 5.7: Example of item statement from the behavioural belief scale for physicians

Avoidance of colonisation of a central line as a result of implementing evidence-based infection control measures during insertion of a central line is desirable						
1	2	3	4	5	6	7
Strongly agree						Strongly disagree

Box 5.8: Example of item statement from the behavioural belief scale for nurses

Reducing patients' length of stay in ICU as a result of implementing evidence-based measures during handling or care of a central line is desirable						
1	2	3	4	5	6	7
Strongly agree						Strongly disagree

5.1.6 Theory of Reasoned Action questionnaire: subjective norm scale

All participants were asked to rate themselves on a three-item, seven-point Likert-type scale ranging from 1 ('strongly disagree') to 7 ('strongly agree'), yielding a total score that could range from a minimum of 3 to a maximum of 21. The items described the perceived social pressure to implement or not to implement the evidence-based CLABSI preventive practices. Descriptive statistics for each item in the subjective norm scale ranked in descending order according to the mean for physicians and nurses and are presented in Appendix 20.

Boxes 5.9 and 5.10 present examples of item statements from the subjective norm scale, for physicians and nurses respectively. The mean score of the subjective norms for physicians and nurses were around the mid-point (4.0), suggesting that both groups perceived a moderate social pressure to implement the evidence-based CLABSI preventive practices. The results indicate that nurses did not expect the colleagues whose opinions they value to give them positive feedback when they implemented the CLABSI preventive measures. The physicians perceived that their colleagues appreciated them when they implemented evidence-based practice. Physicians scored higher in the subjective norm scale (mean 4.8 SD=0.9) compared with nurses (mean 4.3 SD=0.9). This difference was statistically significant t (142) = 3.97, p<0.001.

Box 5.9: Example of item statement from the subjective norm scale for physicians

It is expected of me that I implement evidence-based infection control measures during insertion of a central line						
1	2	3	4	5	6	7
Strongly agree						Strongly disagree

Box 5.10: Example of item statement from the subjective norm scale for nurses

Colleagues whose opinions I value would approve of my implementing the evidence-based infection control measures during handling or care of a central line						
1	2	3	4	5	6	7
Strongly agree						Strongly disagree

5.1.7 Theory of Reasoned Action questionnaire: Normative belief scale

All participants were asked to rate five seven-point Likert-type scale statements ranging from 1 (‘strongly disagree’) to 7 (‘strongly agree’). The score could range from -42 to +42. Scoring of the behavioural belief items is described in Chapter 4, *Part D*, page 120. Items described whether people important to the respondents consider that they should implement the CLABSI preventive measures, and their motivation to comply with those referents. Each item in the normative belief scale was ranked in descending order according to the mean for physicians and nurses and are presented in Appendix 21.

Boxes 5.11 and 5.12 present examples of item statements in the normative belief scale, for physicians and nurses respectively. The median score for the normative beliefs scale for physicians was 17.3 (IQR 3-26) and for nurses 10.0 (IQR 2.1-2.5). The normative belief score for physicians reflects weak to moderate beliefs about the likelihood that their colleagues would think that they should implement the evidence-based CLABSI preventive measures when inserting a central line. The normative belief score for nurse reflects weak beliefs about the likelihood that their colleagues would think that they should implement the evidence-based CLABSI preventive measures when caring for a central line. Physicians scored more highly on the normative belief scale 17.3 (IQR 3-26) than nurses 10.0 (IQR 2.1-2.5). This difference was statistically significant: t=2.636, p=0.009.

Box 5.11: Example of item statement for the normative belief scale for physicians

Other physicians who work in a critical care setting implement evidence-based infection control measures when they insert a central line						
1	2	3	4	5	6	7
Strongly agree						Strongly disagree

Box 5.12: Example of item statement for the normative belief scale for nurses

The approval of my nursing director is important to me						
1	2	3	4	5	6	7
Strongly agree						Strongly disagree

Both professional groups reported the lowest score across all statements, for ‘my medical/nursing director would approve of my implementing evidence-based infection control measures during handling or care of a central line’, indicating that their directors did not motivate them to implement the evidence-based measures relating to CLABSI prevention. Additionally, both physicians and nurses reported a lower than mid-point score (3.9 and 3.3 respectively) for the statement ‘generally speaking, I care what my nurse colleagues think that I should do’, indicating that they were not empowered by their colleagues to halt their practice if they did not implement the evidence-based measures for CLABSI prevention.

The findings for all scales have been summarised in Table 5.2, which presents the mean and median values for self-efficacy, intention performance, attitude, behavioural beliefs, subjective norms and normative beliefs among physicians and nurses in the baseline assessment. This shows that nurses have significantly lower behavioural belief, subjective norm and normative belief scores than physicians.

Table 5.2: Descriptive statistics of self-efficacy, behaviour intention, attitude, behavioural beliefs, subjective norms and normative beliefs among physicians and nurses in baseline assessment

	Physicians (n=56)		**Nurses (n=88)**		***Test statistic***	***Degrees of freedom***	***P value***
	Mean (SD)	**Median (IQR)**	**Mean (SD)**	**Median (IQR)**			
Intention	6.1 (0.7)	6.4 (6-6.6)	6.3 (0.7)	6.6 (5.8-6.8)	1.695	142	0.092[a]
Self-efficacy	4.5 (1.5)	4.8 (3.6-5.7)	4.8 (1.1)	5.0 (4-5.7)	1.295	142	0.197[a]
Attitude	6.0 (1.4)	6.8 (5.8-7)	6.2 (0.9)	6.5 (5.8-7)	0.929	142	0.356[a]
Behavioural beliefs	113.7 (27.4)	114 (99-133)	96.7(29.5)	99.5 (71-124	3.472	142	**0.001[a]**
Subjective Norms	4.8 (0.9)	5.0 (4.2-5.0)	4.3 (0.9)	4.3 (3.7-4.7)	3.977	142	**<0.001[a]**
Normative beliefs	16.0 (16.0)	17.3 (3-26)	8.9 (15.3)	10.0 (2.1-2.5)	2.636		**0.009[b]**

[a] Students t-test [b] Mann-Whitney test SD: standard deviation, IQR: interquartile range
p-values test the difference between physicians and nurses

5.1.8 Correlations between intention performance, self-efficacy, attitude, behavioural beliefs, subjective norms and normative beliefs

Tables 5.3 and 5.4 present the correlations between intention (self-reported adherence), self-efficacy, attitudes, subjective norms, behavioural and normative beliefs for physicians and nurses. The results of Pearson and Spearman's correlation analysis showed that there was a positive moderate correlation between intention (self-reported adherence) and attitudes for physicians and nurses (r=0.34, p=0.01, r=0.33, p<0.001 respectively). There was also a positive moderate correlation between intention (self-reported adherence) and self-efficacy for nurses (r=0.30, p=.004). Likewise, behavioural and normative beliefs had a positive moderate correlation with intention performance for nurses (r=0.28, p=0.008, r=0.22, p=0.04 respectively).

Table 5.3: Correlations between self-efficacy, behaviour intention, attitude, behavioural beliefs, subjective norms and normative beliefs scales for physicians

Total score of		Self-efficacy scale	Attitudes scale	Behavioural beliefs scale	Normative beliefs scale	Subjective norms scale	Intention scale
Self-efficacy scale	r		0.15[a]	-0.20[a]	-0.26[b]	0.01	0.18[a]
	p		0.256	0.143	0.050	0.951	0.198
Attitudes scale	r			0.20[a]	0.08[b]	-0.02[a]	0.34[a]
	p			0.133	0.577	0.871	0.010*
Behavioural beliefs scale	r				0.13[b]	0.40[a]	-0.10[a]
	p				0.349	0.002*	0.458
Normative beliefs scale	r					0.37[b]	-0.02[b]
	p					0.005*	0.891
Subjective norms scale	r						-0.06[a]
	p						0.700

r = correlation coefficient, [a]Pearson's, [b]Spearman's, p = p-value, *p<.05

Table 5.4: Correlations between self-efficacy, behaviour intention, attitude, behavioural beliefs, subjective norms and normative beliefs for nurses

Total score of		Self-efficacy scale	Attitudes scale	Behavioural beliefs scale	Normative beliefs scale	Subjective norms scale	Intention scale
Self-efficacy scale	r		0.17[a]	0.14[a]	0.14[a]	0.15[a]	0.30[a]
	p		0.116	0.203	0.188	0.150	0.004*
Attitudes scale	r			0.21[a]	-0.05[b]	-0.16[a]	0.33[a]
	p			0.046*	0.618	0.140	0.001*
Behavioural beliefs scale	r				0.14[b]	0.13[a]	0.28[a]
	p				0.180	0.218	0.008*
Normative beliefs scale	r					0.47[b]	0.22[b]
	p					<0.001*	0.040*
Subjective norms scale	r						0.04[a]
	p						0.689

r = correlation coefficient, [a]Pearson's, [b]Spearman's, p = p-value, *p<.05

However, the correlations between intention performance and self-efficacy, behavioural beliefs, normative beliefs and subjective norms for physicians was very small and not significant, which suggests these relationships are not important for physicians. Likewise, there was no significant correlation between intention performance and subjective norms for nurses. Overall, these results show that most correlations were either small or medium in size for both physicians and nurses. Moreover, nurses' intention performance was significantly correlated with more of the scales than physicians. These results indicate that both physicians and nurses display a positive attitude regarding their intention to implement evidence-based CLABSI preventive practices. However, only in nurses their colleagues' opinion and their beliefs that implementation of the above practices will reduce CLABSIs influence their intention to do so.

5.1.9 Regression Analysis

Linear regression analysis was applied, with score on the intention scale as the dependent variable. The independent variables were working experience, post-qualification education, scores of self-efficacy scale, attitudes scale and subjective norms scale. Tables 5.5 and 5.6 present the linear regression analysis with scores on the intention scale as dependent variables, for physicians and nurses respectively. The regression model explained 11.1% and 12.6% of the intention scale variation for physicians and nurses respectively and showed that attitude score was the only significant predictor of behavioural intention for both physicians and nurses.

Table 5.5: Linear regression analysis for physicians with score on behaviour intention scale as the dependent variable in baseline assessment

	Standardised coefficient beta	Coefficient beta	Standard error	95% confidence interval for coefficient beta	*P*
Total score on self-efficacy scale	.140	.070	.066	-.064 to .203	.298
Total score on attitudes scale	.348	.185	.070	.044 to .326	.011
Total score on subjective norms scale	-.036	-.031	.113	-.258 to .196	.784
Years of work experience	-.087	-.010	.015	-.039 to .025	.505
Postgraduate education for physicians (yes=1)	.183	.316	.230	-.147 to .779	.176

R^2 = 11.1%, p value for ANOVA < 0.05, F-statistic: 2.4 on 5 and 49 df

Table 5.6: Linear regression analysis for nurses with score on behaviour intention scale as the dependent variable in baseline assessment

	Standardised coefficient beta	Coefficient beta	Standard error	95% confidence interval for coefficient beta	*P*
Total score on self-efficacy scale	.207	.124	.066	-.007 to .255	.064
Total score on attitudes scale	.309	.246	.085	.077 to .415	.005
Total score on subjective norms	.067	.048	.077	-.106 to .202	.537
Years of work experience	.101	.009	.010	-.010 to .028	.353
Postgraduate education for nurses (no=1)	-.025	-.036	.151	-.337 to .265	.812

R^2 = 12.6%, p value for ANOVA < 0.05, F-statistic: 3.7 on 5 and 78 df

5.1.10 Summary from results of Theory of Reasoned of Action and self-efficacy questionnaire

The findings from the self-efficacy and Theory of Reasoned Action questionnaire addressed the first objective of the baseline assessment, which was to assess the physicians' and nurses' behavioural determinants in relation to CLABSI prevention. More specifically, the behavioural determinants of critical care physicians and nurses, in relation to the implementation of evidence-based CLASBI preventive measures, were assessed. A total of 56 physicians and 88 nurses returned completed questionnaires. The results showed that physicians and nurses reported strong intentions to implement all CLABSI preventive practices. Their confidence in their ability to implement the CLABSI preventive measures was influenced neither positively nor negatively by the existing barriers in their working environment. However, some participants felt less confident in their ability to overcome certain barriers (for example lack of supplies) when implementing CLABSI preventive practices. Physicians and nurses showed a positive attitude toward CLABSI preventive best practices, and they appeared to be convinced of the necessity of implementing these practices. However, physicians held stronger beliefs about the likelihood that their implementation of the above practices would lead to positive outcomes. Nurses reported that they did not expect their colleagues to express appreciation toward them when they implemented CLABSI preventive practices. By contrast, physicians reported that their colleagues would approve of their adherence to such practices. Both groups reported that their own director's approval matters to them when they implement CLABSI preventive practices, but they believe that they would not provide them with positive feedback when implementing these practices.

The overall results of the baseline assessment indicated that elimination of certain barriers, enhancement of leadership, positive feedback and role modelling all motivate physicians and nurses to implement CLABSI preventive practices. In addition, only their own attitude was considered an important factor by HCWs in forming their intention to implement CLABSI preventive practices.

5.2 Results from assessment of context

The second aim of the baseline period was to assess the contextual barriers and facilitators influencing CLABSI prevention at the intervention site. A knowledge test (Labeau et al. 2009) and the Context Assessment Index (CAI) (McCormack et al. 2002) were distributed to the critical care physicians and nurses employed at the intervention site. In addition, non-participant observation of the ICU context and informal discussions with the staff were undertaken. Baseline CLABSI rates, and HCWs' adherence to the CLABSI evidence-based practices (namely CVC insertion, handling and site care) were also established. The following section profiles the physicians and the nurses of the intervention site.

5.2.1 Participants' demographics at the intervention site

The knowledge test and the CAI questionnaire were distributed to 37 physicians and nurses employed at the intervention site (ICU 1 in hospital A, Chapter 4, Figure 4.2). The total population of nurses in the unit was 20 (n=20) and the total population of physicians in the unit was 17 (n=17). All participants completed the abovementioned questionnaires, representing a response rate of 100%.

The demographic characteristics of the respondents are presented in Table 5.7. The mean age of the physicians was 41.2 years (SD=7.0 years) and of the nurses 35.0 years (SD=7.3 years). The majority of respondents were females (n=27, 73%). The median working experience at the intervention site was 2.0 years for the physicians and 4.0 years for the nurses. One third of the physicians (n=5) held the intensive care medicine specialty and 35% of nurses (n=7) held a qualification in critical care nursing. Nearly half of the physicians (47.1%) held a PhD and one nurse held an equivalent degree.

Table 5.7: Demographic characteristics of 37 participants employed in the intervention site during baseline assessment

	Physicians (n=17) (n=20) N (%)	Nurses N (%)
Gender (%)		
Female	11 (64.7)	16 (80.0)
Male	6 (35.3)	4 (20.0)
Age (*years*), *mean (SD)*	41.2 (7.0)	35.0 (7.3)
ITU work experience *(years), median (IQR)*	2.0 (0.3 – 7.8)	4.0 (2.5 - 4.8)
Appointment level for *physicians*		
Consultant	2 (11.8)	
Resident	7 (41.2)	
Fellow	8 (47.0)	
Appointment level for ***nurses***		
Nursing manager-Deputy manager		2 (2.4)
Staff nurse		17 (85.0)
Post academic studies		
Medical specialty	5 (29.4)	
Specialty in critical care medicine	5 (29.4)	
MSc	3 (17.6)	
PhD	8 (47.1)	
Specialty in medical/surgical nursing		3 (15.0)
Specialty in critical care nursing		7 (35.0)
MSc		4 (20.0)
PhD		1 (5.0)

5.2.2 Knowledge test

All participants were asked to undertake a ten-question multiple-choice, self-completed knowledge test. An incorrect answer was allocated 0 points. The maximum possible score was 10 points and the minimum 0 points. Table 5.8 presents the knowledge test and shows the percentages of physicians and nurses who chose each response.

The highest percentages of correct answers by the physicians were found in the questions related to the frequency of CVC replacement (Q5 n=17, 88.2%) and the frequency of CVC replacement over a guidewire (Q6 n=17, 88.2%). The lowest percentages of correct answers by physicians were found in Question 10, which asked about the type of dressing that is recommended to cover the catheter insertion site (n=17, 23.5%). All nurses correctly answered Question 3, which asked about the frequency of CVC replacement when lipid emulsions are administered. Nearly all of the nurses (n=19, 95%) answered Question 9 correctly; this question concerned the frequency of replacement for CVC site dressings.

Table 5.8: Physicians' (n=17) and nurses' (n=20) answers to multiple-choice questions regarding CLABSI prevention

	Nurses (n=20) Percent of Answers	**Physicians (n=17)** Percent of Answers
1. It is recommended to disinfect the CVC insertion site with:		
a. 2% aqueous chlorhexidine	30.0	41.2
b. 0.5% alcoholic chlorhexidine	65.0	47.1
c. 10% povidone-iodine	5.0	11.8
d. I do not know	0.0	0.0
2. It is recommended to apply an antibiotic ointment at the insertion site of a CVC:		
a. Yes, because it decreases the risk for CLABSIs	0.0	0.0
b. No, because it causes antibiotic resistance	25.0	29.4
c. No, because it does not decrease	45.0	64.7
d. I do not know	30.0	5.9
3. When lipid emulsions are administered through a CVC it is recommended to replace the administration set:		
a. Within 24 hours	100.0	70.6
b. every 72 hours	0.0	11.8
c. every 96 hours	0.0	5.9
d. I do not know	0.0	11.8
4. When neither lipid emulsions nor blood products are administered through a CVC it is recommended to replace the administration set:		
a. every 24 hours	0.0	0.0
b. every 48 hours	40.0	23.5
c. every 96 hours	60.0	52.9
d. I do not know	0.0	23.5
5. It is recommended to replace a CVC routinely:		
a. Yes, every 7 days	40.0	11.8
b. Yes, every 3 weeks	15.0	0.0
c. No, only when indicated	45.0	88.2
d. I do not know	0.0	0.0
6. It is recommended to replace a CVC over a guidewire:		
a. Yes, every 3 days	0.0	0.0
b. Yes, every 7days	15.0	0.0
c. No, only when indicated	55.0	88.2
d. I do not know	30.0	11.8
7. It is recommended to replace pressure transducers and tubing routinely:		
a. Yes, every 4 days	35.0	41.2
b. Yes, every 8 days	15.0	11.8
c. No, only when indicated	45.0	47.1
d. I do not know	5.0	0.0
8. In settings with a high rate of catheter-associated infections it is recommended to use a CL coated or impregnated with an antiseptic agent:		
a. Yes, in patients whose CL is expected to remain in place for more than 5 days	15.0	41.2
b. No, because the use of such catheters is not cost-effective	5.0	5.9
c. No, because the use of such catheters does not ensure in a significant decrease in the rate of CLABSIs	35.0	41.2
d. I do not know	45.0	11.8
9. It is recommended to change the dressing on the catheter insertion site:		
a. On a daily basis	0.0	35.0
b. Every three days	5.0	0.0
c. When indicated (soiled, loosened etc) and every 2 days for gauze dressings and at least weekly for transparent dressings	95.0	64.7
d. I do not know	0.0	0.0
10. It is recommended to cover up the catheter insertion site with:		
a. Polyurethane dressing (transparent, semi-permeable)	80.0	70.6
b. Gauze dressing	0.0	0.0
c. Both are recommended because the type of dressing does not affect the risk for CLABSIs	20.0	23.5
d. I do not know	0.0	5.9

Correct answers according to CDC are highlighted in light blue colour (O'Grady et al. 2011)

Table 5.9 presents physicians' and nurses' mean scores on 10 questions of the knowledge test. Table 5.10 demonstrates the mean scores on the 10 questions by respondents' professional characteristics.

Table 5.9: Physicians' and nurses' mean score on 10 questions in knowledge test

	Mean	SD[a]	Test statistic	Degrees of freedom	*p*-value[b]
Total sample (n=37)	5.1	1.9			
Profession					
Physicians (n=17)	5.4	2.4	0.972	35	0.338
Nurses (n=20)	4.8	1.4			

[a] Standard deviation [b] Student's t-test

Table 5.10: Physicians' and nurses' mean score, according to their professional characteristics, on 10 questions in knowledge test

Physicians	Mean	SD[a]	Test statistic	Degrees of freedom	*p*-value[b]
Years of ICU experience					
≤4 years	4.0	1.8	4.24	14	0.001
>4 year	7.7	1.5			
Postgraduate qualifications					
No	5.2	2.1	0.31	15	0.764
Yes	5.5	2.6			
Nurses					
Years of ICU experience					
≤2 years	5.4	1.1	1.11	18	0.280[b]
>2 year	4.6	1.5			
Postgraduate qualifications					
No	4.3	1.5	0.86	18	0.403[b]
Yes	5.6	2.5			

[a] Standard deviation [b] Student's t-test

Physicians and nurses scored similarly in the knowledge test. The physicians' ICU working experience was associated with their performance in the knowledge test ($p<0.001$), while those with more than 2 years of experience scored higher than their colleagues who had an ICU experience less or equal to 2 years (mean 7.7 and 4.0, respectively). Moreover, physicians who held postgraduate qualifications performed slightly better than their colleagues who did not have such qualifications (mean 5.6 and 4.3, respectively).

5.2.3 Context Assessment Index (CAI)

All participants were asked to rate themselves on a 37-item, four-point Likert-type scale ranging from 1 ('strongly agree') to 4 ('strongly disagree'). The score in the CAI ranges from 25% to 100% (from weak to strong context). Scoring of the CAI is described in Chapter 4, *Part E*, page 120. The items address HCWs' perceptions about the organisation's readiness to implement evidence-based practice. The mean and median values of the total CAI score (%), and the mean and median values of the three sub-scales among physicians (n=17) and nurses (n=20), are presented in Table 5.11. Each of the CAI sub-scale (*culture, leadership and evaluation*), items were ranked according to the mean for physicians and nurses, are presented in Appendix 22.

Nurses scored lower (mean 60.8 SD=9.0) for total CAI score compared to physicians (mean 76.1 SD=8.9); this difference was significant t (5.23), *df*=35, $p<.001$. Nurses also scored lower in the culture sub-scale (mean = $p<.001$), leadership sub-scale ($p<.001$) and evaluation sub-scale ($p=0.001$) compared with physicians.

Table 5.11: Descriptive statistics of three sub-scales of CAI for nurses (n=20) and physicians (n=17)

	Nurses		Physicians				
	Mean (SD)	Median (IQR)	Mean (SD)	Median (IQR)	**p-value[a]**	**Test statistic**	**Degrees of freedom**
Total score of culture scale (25% to 100%)	61.3 (11.3)	57 (52.3 - 70.3)	76.0 (10.0)	78.1 (70.3 - 82.8)	**<0.001**	**4.18**	**35**
Total score of leadership scale (25% to 100%)	55.5 (9.5)	55.3 (50 - 62.5)	76.2 (8.7)	78.5 (71.4 - 82.1)	**<0.001**	**6.85**	**35**
Total score of evaluation scale (25% to 100%)	65.5 (8.8)	65.9 (61.4 -71.2)	76.1 (9.7)	76.5 (71.2 - 85.4)	**0.001**	**3.49**	**35**
Total score of CAI (25% to 100%)	60.8 (9.0)	60.6 (55.5-66.1)	76.1 (8.9)	78.8 (69.7 - 82.3)	**<0.001**	**5.23**	**35**

[a] *Students t-test*

5.2.4 Results from structured observation of CLABSI preventive practices

Thirty-two CVC insertion, 79 CVC handling and 18 CVC site care observations were conducted during the baseline assessment. The structured observation process is described in Chapter 4, Section 4.6.3. The baseline adherence rates for CLABSI evidence-based preventive practices are demonstrated in Table 5.12.

In respect of CVC insertion, the rate of adherence to evidence-based measures was very high (n=31, 97%). However, the rate of adherence to evidence-based measures for CVC handling was very low (n=9, 11.8%), due to very low adherence (n=14, 17.7 %) to the Aseptic Non-Touch Technique prior to accessing the catheter. Adherence rates for disinfection of the port or the hub of the catheter (*'scrub the hub'*) with an antiseptic agent, and accessing of the catheter only with sterile devices, were high (n=64 81% and n=69 91% respectively) among nurses.

Table 5.12: Baseline adherence to CLABSI preventive practices

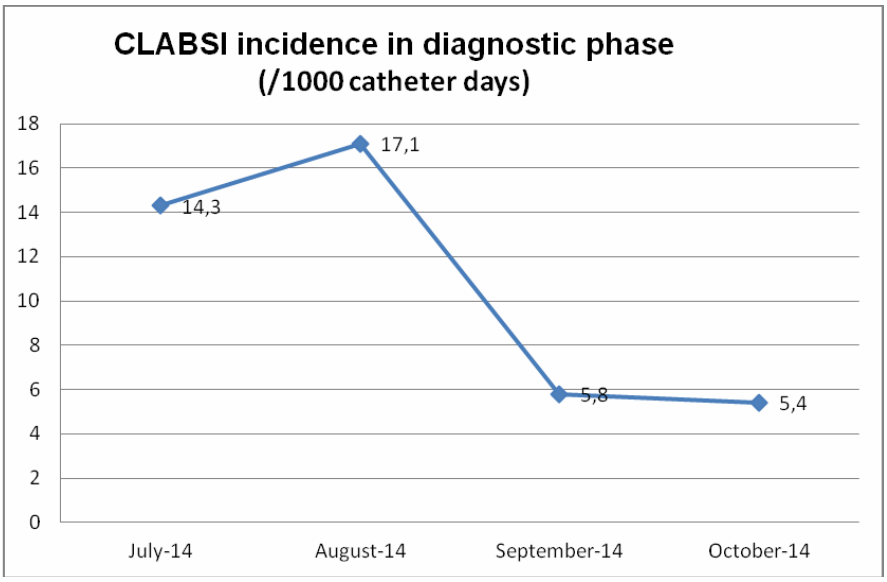
Physicians	Correct practices/ observed practices
Insertion, n (%)	
Hand hygiene	32/32 (100.0)
Skin disinfection with CHX 2%	31/32 (96.8)
Maximal barrier precautions	32/32 (100.0)
Skin preparation agent completely dry at time of first skin puncture	32/32 (100.0)
Total adherence (all-or-none-measure)	31/32 (97.0)
Nurses	
Handling, n (%)	
Hand hygiene	68/79 (86.0)
Don clean gloves	76/79 (96.2)
Maintain Aseptic Non-Touch Technique	14/79 (17.7)
Scrub the hub	64/79 (81.0)
Access only with sterile device	69/79 (91.0)
Total adherence (all-or-none-measure)	9/79 (11.8)
Nurses	
Site Care, n (%)	
Hand hygiene	14/18 (78.0)
Clean/sterile gloves	18/18 (100.0)
Skin disinfection with aseptic technique	18/18 (100.0)
Apply sterile dressing with aseptic technique	18/18 (100.0)
Aseptic technique maintained	18/18 (100.0)
Total adherence (all-or-none-measure)	14/18 (77.8)

These results indicate that the major problem regarding CVC handling practice was nurses' non-maintenance of clean hands prior to accessing a catheter. Both maintenance of appropriate hand hygiene and usage of sterile gloves during CVC site care also showed high rates (n=14 78%, n=10 100%). Overall, the results from the structured observation revealed that physicians' performance was excellent during the insertion of a CVC. In contrast, nurses' adherence to CVC handling practice was very low, mainly due to very low adherence to the maintenance of aseptic technique before accessing the CVC. Nevertheless, nurses performed optimally during CVC dressing replacement.

5.2.5 CLABSI rate during the baseline period

The monthly CLABSI rate during the baseline period is demonstrated in Figure 5.1. The calculation of CLABSI rate is displayed in table 4.7, Chapter 4, section 4.6.5, page 130 of the thesis. During the baseline period (July 2014 to October 2014), the mean CLABSI incidence rates was 10.49/1,000 catheter days.

Figure 5.1: CLABSI incidence at intervention site



CLABSI rates during the baseline period show a downwards trend although the measurements are too few to draw strong conclusions. Moreover, there were no evident changes in the patients' and the unit's characteristics that would account for the lower CLABSI rates in the last two months of the baseline period. Details of the patients and the intervention site characteristics are presented in Table 5.13.

Table 5.13: Patient and intervention site characteristics in baseline period

	Baseline period: July 2014-October 2014
Total patient admissions	47
Mean APACHE II score (SD)	21.4 (±8)
Patient days	691
Catheter-days	665
CVC usage ratio	96.2%
Time to CLABSI occurrence (days)	13.8
Total number of physicians (n)	17
Total number of nurses (n)	20
Active ICU beds (n)	10

5.2.6 Findings from non-participant observation during the baseline period

The findings from observation of the context of the intervention site were grouped into two categories – barriers and facilitators with regard to CLABSI prevention. Accounts from informal discussions with HCWs were content-analysed into themes, following a content analysis process which is described in Chapter 4, Section 4.10.3. Identified themes characterised physicians' and nurses' experiences with regard to infection control and prevention, and specifically to CLABSI prevention in daily practice. Contextual barriers and facilitators, along with the findings from fieldwork with the HCWs, are described in the following sections.

5.2.6.i Baseline barriers and facilitators to CLABSI prevention identified through observation of the context

Overall, the ICU's culture toward infection control and prevention was adequate, and it was reinforced mainly by the unit's physicians. Structured observation of actual CLABSI practices provided measurable information (adherence rates) regarding the CLABSI issue in the intervention site. However, observation of the working environment and informal discussions with HCWs provided insights into why the latter used certain CLABSI prevention practices but not others. Contextual barriers and facilitators affecting CLABSI prevention at the intervention site are presented in Table 5.14.

Table 5.14: Barriers and facilitators to CLABSI prevention at intervention site during baseline assessment

OBSERVED CONTEXTUAL INFLUENCES ON CLABSI PREVENTION DURING BASELINE ASSESSMENT	
BARRIERS	**FACILITATORS**
Lack of equipment: 3-way taps are re-used after they are disconnected from a central catheter lumen	There is an easily accessible, fully equipped CVC trolley within the ICU
Adequate supply of CVC-related equipment varies month by month	Chlorhexidine 2% is in stock
Use of the Aseptic Non-Touch Technique is limited in relation to IV preparation and administration practices	Standard precaution measures are applied from patient to patient, for example, donning a clean plastic gown and applying hand hygiene
Lack of coherent strategy to prevent CLABSIs	Physicians are actively engaged in in-service education
Lack of an infection control orientation programme for nurses	A full-time infection preventionist physician is employed
None of the ICU nurses has been designated as an infection control liaison nurse	CLABSI rates are occasionally communicated to all staff through e-mails
Clinical guidelines and bundles related to CLABSIs prevention are not available in an easy-to-read format within the ICU	CLABSI cases are discussed in detail during early physicians' handover
No CLABSI prevention checklists are available in written format in the ICU	A teaching physician-led ICU round takes place every afternoon in the presence of the medical director
Nurses are not able to leave the unit to attend teaching tutorials, which are held in another room due to nursing shortage	Intervention site is regularly updated about infection control measures through the Hellenic Center for Disease Control and Infection (KEELPNO)* and the Center for Disease Control and Infection (CDC)
Limited engagement and participation of nurses in the ICU's teaching activities	
Reasons for CLABSI development are not discussed between physicians and nurses during the daily ICU round	
Lack of communication between physicians and nurses during daily ICU round in relation to CVC condition	
Physicians and nurses are not empowered to stop their colleagues in the case of evidence-based practices not being followed	
Head nurse does not attend the two daily ICU rounds	
Nurses do not have protected time for breaks	
No joint meetings between physicians and nurses are held in the ICU	

*KEELPNO: Greek initials corresponding to the National Center for Disease Control and Infection in Greece

5.2.6.ii Observation of the context

At first glance, it seemed that the intervention site ICU had a strong focus on infection control and prevention. However, analysis of the observational findings showed that there was not a coherent strategy for preventing CLABSIs that was based upon the ICU's context. Findings from the structured observation showed that physicians' adherence to CLABSI preventive measures was nearly 100% for CVC insertion, but nurses' adherence to CLABSI preventive measures was suboptimal. During informal discussions, several reasons were given by nurses for their low adherence to these measures, while both the medical and nursing leadership acknowledged that CLABSI prevention was the physicians' responsibility. As the head nurse stated, "the ICU does not have the culture of a shared *[meaning on the part of nurses]* responsibility every time a new CLABSI occurs".

During the baseline period, the intervention site was struggling to cope with a significant budget deficit, due to the country's persistent financial crisis. The main priority of the ICU's head nurse was to retain reserves of equipment for as long as possible, regardless of whether this would compromise the implementation of CLABSI evidence-based practices. For example, disposable three-way taps were not changed every time a CVC was accessed. It appeared therefore that supply constraints led to 'cutting corners', resulting in suboptimal adherence to and implications for CLABSI prevention. The risk of CLABSIs from non-adherence to preventive practices was not routinely monitored or appraised by the staff of the unit. During the observation it was evident that 'shortcuts' were taken in relation to correct practices, which ultimately led to these becoming acceptable habits. Importantly, the nursing shortage was used as an excuse to justify the leadership's reluctance to assume responsibility and ownership of the CLABSI problem.

5.2.6.iii Accounts from informal discussions with HCWs

The following themes were identified from informal discussions with physicians and nurses at the intervention site during the baseline assessment:

Infection control and prevention culture: lack of time to engage with the unit's activities

The medical team had a strong teaching and research culture, which included in-service education for the physicians, weekly and monthly lectures, and their participation in research projects and publications. The medical leadership empowered physicians to allocate their time between clinical, research and teaching activities. However, this was not the case for the nursing team. The nursing shortage and lack of time were claimed by nurses as being the main barriers to them participating and being involved with the unit's in-service education. One nurse described it thus (in a complaining manner):

> "there are no teaching activities for us...we have to update our knowledge by ourselves..." (N1)

Many of the unit's teaching activities took place during Saturdays and most of the physicians attended them; however, nurses seemed unable to do so during their days off duty. One nurse explained:

> "...if I am off that weekend it means that I am doing nothing related to my job." (N2)

However, she would consider attending teaching sessions if she was given a study day. Another nurse added:

> "...offering me a study day does not work for me." (N3)

Another nurse stated:

> “…there is no time for me to do anything while being at home...if the teaching sessions were uploaded into the unit’s PC, I would be able to read them during my nights...” (N4)

The layout of the ICU was reported by nearly all nurses as being a barrier. This was due to the fact that the teaching room was located outside of the main ICU area and the unit did not facilitate nurses’ attendance at teaching sessions. Nurses explained that there was not a spare nurse available to relieve them during their absence, given that each nurse was looking after two to three patients. While the nurse in charge (according to nurse staff structuring in Greece, this would be the most senior nurse below the ICU nursing manager) was in the area of the ICU during the early shift, the unit’s tacit rule dictated that she was engaged mainly in managerial rather than clinical work. Therefore, the culture and hierarchy among nurses did not encourage them to ask the nurse in charge for assistance; on the other hand, she had herself never offered to relieve nurses during teaching sessions. Few physicians stated that they would be willing to relieve nurses during a teaching session, but as one said:

> “I am not sure if my colleagues would welcome this proposal.” (P1)

While nurses attributed their lack of participation and involvement in in-service education to their increased workload, most of the unit’s physicians considered that nurses were reluctant to attend any teaching activities. A physician explained (in a raised voice):

> “I think that nurses do not care...they only care to finish their shift…last year we organised a course for CLABSI prevention and the attendance from the unit’s nurses was minimal.” (P2)

Another physician acknowledged:

> “…not all nurses seem reluctant to be developed...some nurses are very keen on learning, we work together during night shifts and they keep asking me things about their patients’ condition etc.” (P3)

<u>*Lack of time due to increased workload*</u>

Increased workload was also regarded by most of the nurses as a barrier to them implementing CLABSI preventive measures. A nurse explained:

> “…last night the unit was so busy…I doubt if the night nurse had the time to change the IV administration sets…” (N5) *[according to CLABSI guidelines, IV medication sets must be changed every 96 hours]*

Another nurse also stated aloud while she was handling her patient’s CVC:

> “…there is chaos with my patient...I am doing everything wrong...” (N6)

while another nurse admitted:

> “...if you have to look after two patients and you have an emergency…you won’t disinfect the CVC port…regardless of the recommendations of the guidelines...” (N7)

Communication

Lack of communication between physicians and nurses also rendered the CLABSI prevention measures ineffective. While nurses accessed and cared for the CVCs, no specific information about the condition of the CVC was recorded on a patient's daily chart. Thus, neither the attending physicians, nor the nurses on the following shifts, were aware of the condition of the CVCs. Daily review of the necessity for CVCs was not discussed during the ICU round. As the medical director admitted:

> "...unfortunately, we do not do this here…" *[at the ICU]*

without providing a firm reason for this. (P4)

Nurses made very little contribution during the ICU round for two main reasons: (a) physicians almost never asked for their input, and (b) nurses appeared unable to spend approximately 30 minutes (the duration of the round for each patient) simply to hearing about their patient's progress, as they were struggling to complete the shift's nursing tasks.

Low morale: lack of respect and recognition

One key element identified was that nurses felt a lack of respect and recognition**.** **I**t was apparent that nurses worked well together; however, they had low expectations regarding nurse-physician collaboration, perhaps due to the ICU's medically driven system. A nurse explained:

> "…top management of the unit is medically oriented",

implying that the head nurse's voice is not heard enough. (N8)

There were several similar accounts from nurses that highlighted a hidden negative emotional culture:

> "…they *[physicians]* are never pleased with what we do...they just do not appreciate our contribution to the patients." (N9)

Another nurse admitted:

> "I feel that my practice is underestimated...I am here *[in work]* for doing baths, suctioning the patient and giving meds to my patient..." (N10)

Some other nurses wondered:

> "...it is confusing though...they *[physicians]* trust us...they go to rest at 4.00 a.m. and they leave us alone with the patients for four to five hours." (N11)

ICU physicians considered that nurses had a lack of knowledge which, in combination with their poor attendance at the ICU's teaching activities and the ICU round, made them 'less competent' to play a key role in the multidisciplinary team. The medical director explained, showing signs of dissatisfaction:

> "I know that some of them don't even know what their patient's underlying disease is when there is a new admission…she *[the nurse allocated to a patient]* did not know...his *[the patient's]* name, age, vital signs, cause of admission..." *[she strongly exhaled]* (P4)

Another physician strongly stated (in a raised voice):

> "…they *[nurses]* don't know a thing *[about their patient's condition]*...they better start doing some studying first." (P5)

Teamwork

The challenges described above were further compounded by a lack of teamwork between physicians and nurses, which, as it was described by the infection preventionist physician, could hardly be ameliorated:

> "I can't rely on them *[nurses]*. Some of them do not even know what their patients have *[what their illness is]*...they have drawn a red line and they placed us *[physicians]* on the other side of the line...I do not have the energy to work with them. Somehow they have disappointed me..." (P6)

This physician, however, strongly valued the nursing contribution in the ICU, as he stated:

> "I believe that nurses are the most essential part of an ICU...we *[physicians]* do very little." (P6)

Nurses also expressed their negative feelings regarding the unit's teamwork:

> "Professional boundaries are very clearly defined here *[in the ICU]*... we are not a team...we belong to two different worlds." (N12)

Another nurse stated:

> "I am here *[pointing with a finger to the ground]* and they *[physicians]* are there *[pointing to the ceiling]*. (N13)

While it appears that some of the above issues could be resolved through joint meetings between physicians and nurses in order to open up dialogue, neither the medical nor nursing leadership facilitated this type of communication. Some nurses said that:

> "I would like to attend joint meetings with the physicians…" (N14)

while a physician remarked:

> "What's the point of organising joint meetings...nurses wouldn't appear." (P7)

5.3 Summary of findings from the knowledge test, context assessment index, structured observation and fieldwork

This chapter presented results from the knowledge test, the CAI, CLABSI rates of incidence, rates of adherence to CLABSI practices, and findings from observation of the context at the intervention site during the baseline period of the study.

A total of 17 physicians and 20 nurses employed at the intervention site completed the knowledge test and the CAI. The results of the knowledge test showed that both groups scored correctly in approximately half of the ten-question test, indicating that in-service education regarding CLABSI prevention might be necessary. Physicians perceived a greater readiness within the ICU to use evidence-based practices compared with nurses. Culture, leadership and evaluation of practices within the ICU environment were also perceived as higher by physicians compared with nurses. These results indicated that physicians were grouped together as a team focusing on translation research into practice, and on infection control and prevention in general.

CLABSI rates at the intervention site during the four-month baseline period fell within the range of previously reported CLABSI rates in Greek ICUs (n=33) (Papadomichelakis 2012), highlighting that CLABSI rates, and HCAIs in general, constitute a major problem for the Greek national healthcare system. Adherence to CVC insertion practices was very high, indicating the strong infection control culture of the physicians at the intervention site. By contrast, nurses' adherence to CVC handling practices was very low, indicating a shortcoming in nurses' practices related to CLABSI prevention.

Findings from context observation and informal discussions with the staff revealed that a lack of cohesive culture and nurses' low morale, coupled with a lack of teamwork and communication, contributed to ineffective reasoning and suboptimal adherence to CLABSI preventive practices. It appeared that both the medical and nursing leadership have accepted that high CLABSI rates and suboptimal adherence cannot be improved, due to the persistent constraints of increased nursing workload and nursing shortage within the ICU. On the other hand, very little effort was made to create a culture of 'working together' through improved teamwork and communication among physicians and nurses.

The next chapter describes the development of the intervention, based on the findings identified in the baseline assessment. It also provides a rationale for the selection of the intervention's components.

Chapter 6: Design of the intervention: task force formation, process to select the components of the intervention, report of the content

6.1 Introduction

Although largely preventable, CLABSIs remain associated with increased morbidity, risk of death, and length and cost of hospitalisation (Lin et al. 2017). Previous quality improvement (QI) interventions have been successful in reducing CLABSI rates in the ICU setting; however, their effect has been small and not sustained (Blot et al. 2014). It is strongly advocated that a theory (of why and how an intervention might be successful) should inform the design of an intervention (Dixon-Woods et al. 2011). However, in practice the development of most QI interventions is based on personal intuition and implicit knowledge (Eccles et al. 2006, Hrisos et al. 2008). There is also a lack of an explicit rationale for intervention choice, and hence the ability to improve similar QI interventions is limited (Steinmo et al. 2015). Moreover, contextual factors previously linked to successful implementation of QI interventions have not been adequately explored (Eccles et al. 2009).

This chapter describes the process that was followed to develop the intervention of the study. Firstly, the formation of the task force responsible for the development of the intervention is presented. Secondly, the process followed to develop the final content of the intervention is described, by providing an explanation for the selection of the intervention's components. Finally, the content of the intervention is reported.

6.2 Formation of the task force: setting the scene

Initially, a task force was assembled to determine the content of the intervention. The aim was to bring together those physicians and nurses from the intervention site who would have the greatest opportunity to support and facilitate the implementation of the intervention. HCWs from the intervention site were invited to participate in the task force after discussing the study objectives with the medical director and ICU nursing manager. Those individuals who accepted the invitation (three physicians and three nurses) were experts in the field of infection control, had significant previous clinical experience, and were able to act as change agents. The task force combined scientific expertise and emotional engagement with the ICU's physicians and nurses, and it was envisaged that it would ensure the implementation of the intervention through discipline and local ownership (Dixon-Woods et al. 2011). The members of the task force were: the medical director, the ICU nurse manager, two frontline nurses, one consultant intensivist physician and one consultant infection preventionist physician. The researcher, who was leading the implementation of the research project, was also a member of the task force.

As soon as the analysis of findings from the baseline assessment was completed, all members of the task force met, to establish rapport between them, to understand the functional objectives of the task force, and to agree the frequency of their meetings. It was anticipated that through regular and effective meetings the task force members would reach a common ground and consensus about the intervention's components (Guerrero et al. 2017). Additionally, all task force members were provided with a badge (Figure 6.1) which displayed the words 'task force' along with the intervention's logo: 'CLABSI-free Entatiki' (this means 'intensive' in Greek). This novel strategy for the use of badges, was considered that it would support the task force members in feeling that they shared a common research identity and would foster their sense of ‘ownership’ of the research project.

Figure 6.1: Badge worn by task force members

The medical director was very enthusiastic and supportive about the research project. She identified several potential opportunities for the ICU, namely opening up the ICU to cooperation with a globally highly-rated research institution, participation in a research project, and, most importantly, the opportunity to improve the ICU’s infection control practices, in addition to obtaining evidence about the reasons behind the unit’s high CLABSI rates. In contrast, the ICU nursing manager had reservations about nurses’ engagement in the research project and was concerned that nursing staff would have to take on additional duties related to the project’s activities. Given that eight ICU nurses had left the unit prior to the beginning of the intervention period, beliefs about whether such low number of nurses make sense in a working environment where research activity takes place seemed to be the major obstacle to him welcoming research activity in the intervention site. The head nurse’s view was consistent with the Kotter &

Schlesinger (1989) reasons (self-interest) for people who present with resistance to change. It has been illustrated that it is challenging for frontline nurses to find a balance between providing competent care to patients with life-threatening conditions and following a research protocol. Similarly, unexpected patterns of staff turnover, as occurred in the intervention site immediately before intervention, may impose extra burdens on nurses, leading to them having less involvement in the research also supported by Roll et al. (2013). However, by presenting existing evidence (Price & Reichert 2017), the researcher was able to highlight that engaging nurses in the research would contribute to an enhancement of the staff's knowledge about CLABSI prevention, and would increase their readiness to implement evidence-based practice

As was previously mentioned, the members of the task force were experts in their fields; however, they had limited understanding of the concepts and methods related to the science of quality improvement and implementation. These two scientific fields have not been defined within the Greek healthcare system, since they are insufficiently studied and researched. In contrast to the Greek context, implementation science has been a recognised area internationally in terms of research, training of healthcare workers, university training programmes, and knowledge infrastructure for implementation (Eccles et al. 2009). The following section describes the steps that were followed to develop the intervention of the study.

6.3 Development of a theory-based intervention

Using the data collected in the baseline assessment (identification of barriers and facilitators to physicians' and nurses' adherence to CLABSI preventive measures) a theory-based intervention was designed that incorporated behavioural change approaches, intended to overcome the identified barriers and facilitators to adherence to CLABSI preventive measures by critical care physicians and nurses.

A three-step approach was used, consisting of generating questions and answers to facilitate the development of the most appropriate intervention. The three steps were:

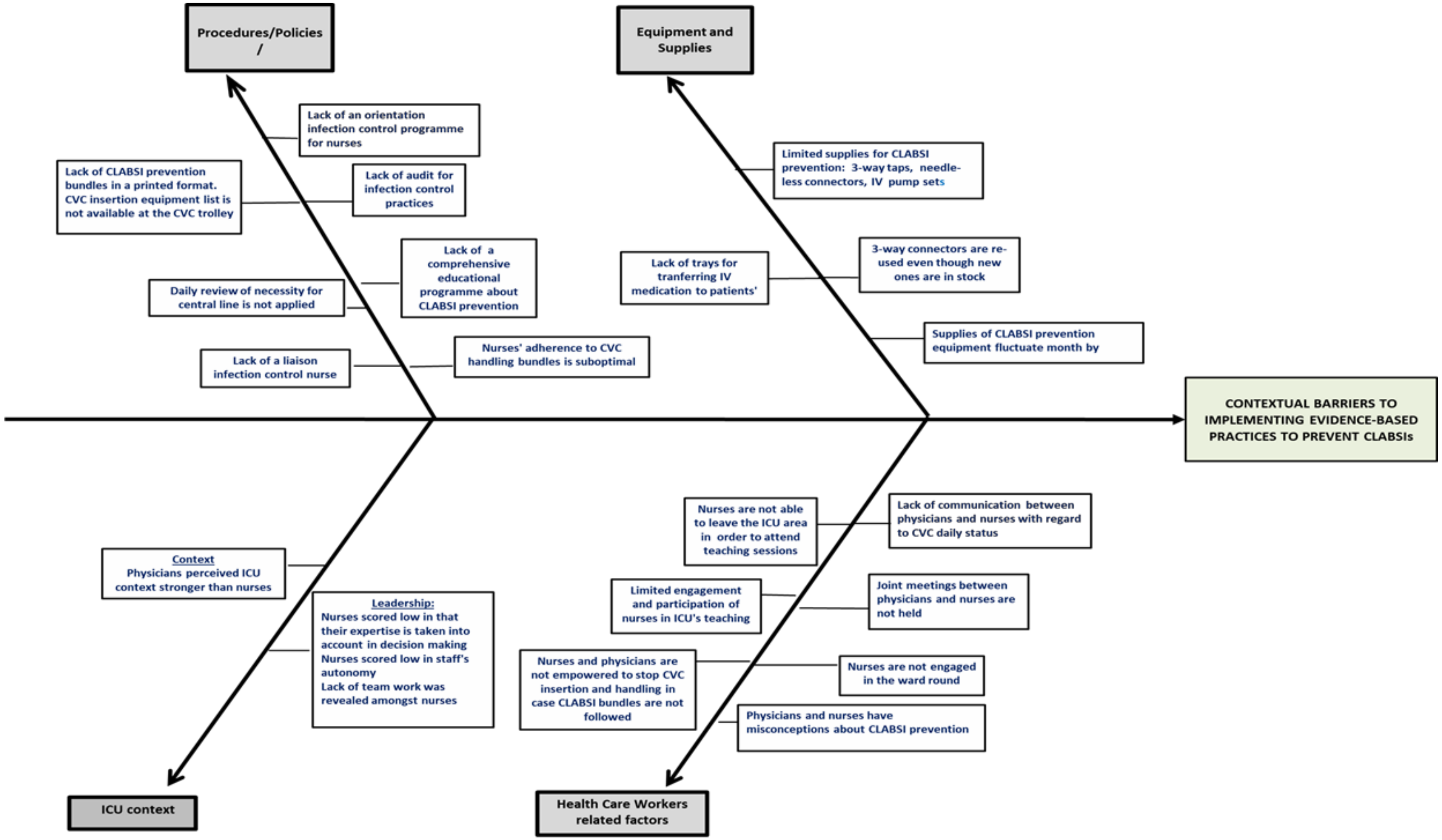
- selection of the barriers and facilitators needing to be addressed
- identification of the most appropriate components, which could overcome the identified barriers and enhance the facilitators, and
- evaluation of the intervention.

Step 1: Which barriers and facilitators need to be addressed?

In the first meeting, the researcher presented the barriers and facilitators, as these have been identified in the baseline assessment, to the task force members. Figure 6.2 demonstrates the barriers and facilitators in a fishbone format. It was decided to use a 'fishbone' or a 'cause-effect' diagram instead of developing a table, which could look dense and would not allow the team to grasp the causes behind the CLABSI problem at a glance (McCormack et al. 2013). It was envisaged that a visual aid could keep the team members focused throughout the meeting and would facilitate decision-making among them. A fishbone diagram (Ishikawa 1985) has been also previously used for cause-and-effect analysis in patient safety initiatives (Cherry-Bukowiec et al. 2011, McMullan & Gordon 2016).

The baseline assessment identified a substantial number of barriers and facilitators and given that it was not considered possible to target all of these the task force agreed to prioritise certain specific barriers and facilitators.

Figure 6.2: Cause and effect analysis (fishbone diagram) of CLABSI prevention



A formal systematic approach was then applied, to identify which barriers and facilitators should be prioritised. Two criteria were considered for their selection: importance and capability of change (van Boklhoven et al. 2003). Thus, if a barrier or a facilitator was not considered important for the reduction of CLABSIs within the ICU context, it would not be targeted. For example, joint meetings between nurses and physicians were not held in the ICU setting. Task force members acknowledged that joint meetings would enhance HCWs' communication. However, both medical and nurse directors considered joint meetings to be only a minor factor in improving communication between physicians and nurses. It would therefore not be useful to include that approach to communication enhancement within the study's intervention. A similar view was applied to potential capacity for change – for example, there was a lack of information exchange between physicians and nurses about the condition of CVCs. A CVC daily goal sheet was therefore proposed to be developed. However, nursing members of the task force were reluctant to introduce an additional checklist into their daily practice, having regard to the increased workload resulting from the ICU's nursing shortage. It was, however, considered unlikely that the nursing staff of the ICU would change, given that the employment of staff was determined by governmental policies.

Table 6.1 presents the barriers and facilitators addressed within the above process. Fifteen barriers (n=15) and two facilitators (n=2) were finally selected to be targeted. The barriers to be addressed were then linked to the domains in which they operate. Fifteen barriers (n=15) were linked to resources, skills, leadership, HCWs' knowledge about CLABSI prevention, evaluation of practices, beliefs about capabilities and social support. Among the targeted facilitators, one facilitator was linked to resources and one facilitator was linked to beliefs about positive consequences. As soon as the targeted barriers and facilitators were agreed, they were then tabulated according to whether they were identified using the survey questionnaire (SQ), structured observation (SO), context observation (CO) or informal discussions (ID).

Table 6.1: Barriers and facilitators and the domains in which they operated

Addressed barriers (n=15) (data source)	**Domains in which barriers and facilitators operated**
CLABSI prevention guidelines are not available in an accessible and convenient format (CO)	Resources
Nurses are not familiar with the CVC insertion procedure when they assist physicians to insert a CVC (CO)	Knowledge
Absence of in-service education with regard to CLABSI prevention (CO); physicians and nurses have misconceptions about CLABSI prevention guidelines (SQ, ID, SO, CO)	Resources, Knowledge
Nurses are not familiar with the aseptic-non-touch technique (ANTT) during preparation of IV solutions (SO, CO)	Skills
Absence of audit of infection control practices; infection control and prevention are mainly responsibility of infection preventionist physician (ID); nurses are not involved and not engaged in infection control and prevention processes undertaken in the intervention site (CO, ID)	Evaluation of practices, Leadership
Lack of trays for preparing and transferring IV medication to the patient (SO, CO); limited supplies for CLABSI prevention: 3-way connectors, needle-less connectors, IV pump sets (CO); supplies related to CLABSI prevention fluctuate month by month (ID)	Resources
Nurses are not able to leave the ICU area in order to attend teaching sessions (CO, ID); limited engagement and participation of nurses in ICU's teaching activities (CO, ID)	Resources, Leadership
Lack of supplies limits physicians' and nurses' ability to implement CLABSI preventive measures (SQ)	Beliefs about capabilities
Lack of positive feedback from medical and nursing directors when physicians and nurses implement CLABSI preventive measures (SQ); physicians and nurses seek their medical and nurse directors' approval (SQ)	Social support
Addressed facilitators (n=2) (data source)	
Physicians' and nurses' intention to implement CLABSI preventive measures is significantly related to their attitudes about the positive consequences of implementing CLABSI best practices (SQ)	Beliefs about positive consequences
A CVC trolley is located centrally in the main ICU area (CO)	Resources

CO: context observation, SO: structured observation, ID: informal discussions, SQ: survey questionnaire

Direct observation of the behaviour identified the largest amount of data regarding the barriers to and facilitators of CLABSI prevention, suggesting the usefulness of the method in collecting 'real-world' data in the participants' natural setting (Steinmo et al. 2015). The fact that more than one data collection method revealed the same barrier or facilitator indicates the strength of evidence supporting the specific barrier. Moreover, this provides a more comprehensive description of the influences on HCWs that relate to CLABSI prevention (Steinmo et al. 2015).

Step 2: Which intervention components (content / mode of delivery / frequency of delivery) could overcome the addressed barriers and enhance the facilitators?

Having identified which barriers and facilitators should be targeted (*Step 1*), the next stage was to link these barriers to specific intervention components (what will be delivered in reality). This process was viewed as necessary for two reasons; firstly, it provides evidence of how and why an intervention might work (leading to similar interventions) and secondly, components can be comprehensively described (Michie et al. 2011, French et al. 2012). According to implementation science researchers, lack of specific reporting of what has been delivered, and why, limits the ability to improve the intervention, and thus the benefit from research is limited (French et al. 2012, Hoffman et al. 2014, Steinmo et al. 2015, 2016). Therefore, the task force following three two-hour meetings, decided that the intervention should include the following components (See, table 6.2) that were linked to behavioural and contextual barriers identified in the baseline assessment:

Table 6.2: Components of study's intervention

Environmental changes to aid implementation of practices
Education
Improvement of skills: hands-on-training of nurses
Evaluation of CLABSI preventive practices
Feedback on CLABSI and adherence rates
Changes to policies to improve teamwork
Changes to policies to improve leadership: positive feedback and rewarding
Persuasive communication regarding important consequences to aid implementation of CLABSI preventive practices
Reminders: a. To HCWs to reinforce the consequences of not adhering to CLABSI preventive practices b. Visual reminders regarding hand hygiene and disinfection of the port or hub of a CVC c. Visual cards to remind HCWs of the required equipment for CVC insertion

Selection of whether the above interventions were likely to be effective required a broad canvassing of possible choices, considering the characteristics of the context in which the intervention would be delivered, the target population and the targeted behaviour (Steinmo et al. 2015). The components of each of the above interventions were informed by (a) the literature in relation to their effectiveness for QI – for example, audit and feedback (Day et al. 2009, Ivers et al. 2012) and (b) by empirical evidence and expert consensus regarding how current CLABSI practices should be implemented (this was provided by the physicians and nurses of the task force) – for example, correct application of the Aseptic-Non-Touch Technique (See, Appendix 23).

As soon as the possible components were identified, these were then assessed for: (a) feasibility in the specific context, (b) likelihood of being acceptable to physicians and nurses, and (c) the timeline of the intervention (Squires et al. 2013, Steinmo et al. 2016). Modes of delivery (how each intervention component would be delivered) were also selected. Several delivery modes were available in the clinical setting for the majority of the behavioural change interventions. The experience of the task force team, together with the physicians' and nurses' knowledge of what was acceptable and feasible, was used to determine which modes of delivery should be selected. For example, bedside training was chosen as a delivery mode because hands-on training is familiar, acceptable, and feasible for nurses. Moreover, evidence has shown that hands-on training enables nurses to better retain the procedure as an established part of their routine (Peters & Ten Cate 2013).

The content of the interventions, and the modes of delivery used to overcome the targeted barriers and enhance the facilitators identified in the baseline assessment, are summarised in Table 6.3. The first column indicates the components of the intervention, as agreed by the task force, while the second column indicates the content of the interventions and the modes of delivery, to whom the interventions were delivered and the frequency with which they were delivered.

Table 6.3: Components of the *'CLABSI-free-Entatiki'* intervention implemented in a Greek medical ICU

Intervention	Content of the intervention and modes of delivery to overcome the targeted barriers and enhance the facilitators
Environmental changes to aid implementation of practices	1.*Content*: CLABSI guidelines available in easy-to-read format *Mode*: electronic and printed documents *When/how often*: at the start of the observation and ongoing 2. *Content*: purchase of IV trays for medication administration *When/how often*: at the start of the observation and ongoing 3.*Content*: agreement that hospital will supply the ICU with the required equipment for CLABSI prevention; statement by the head nurse that required equipment for CLABSI prevention will be available *Mode/Delivered to*: hospital's logistic department/physicians and nurses *When/how often*: at the start of the observation and ongoing
Reminders	1.*Content*: visual instruction card describing the type and number of required equipment for a CVC insertion *Mode*: placed on the CVC trolley visual instruction card demonstrating the Non-Touch-Aseptic-Technique *When/how often:* at the start of the observation and ongoing 2.Content: visual reminder of disinfecting the CVC port or hub *Mode*: placed in a visible location within ICU area *When/how often:* at the start of the observation and ongoing 3. *Content:* visual reminder of keeping hands clean *Mode*: placed on monitor in each bed space *When/how often:* at the start of the observation and ongoing
Education	1.*Content*: face-to-face teaching session explaining the correct and incorrect answers to the knowledge test and the related evidence; CVC insertion video *Mode/Delivered to*: face-to-face (group)/physicians; trainee physicians *When/how often*: beginning of the intervention; every time a new trainee started training in ICU *2.Content*: development of an A3 booklet including the above knowledge test questions and answers; discussions about test knowledge test results *Mode/Delivered to*: nurses (within the ICU area) *When/how often*: beginning of the intervention *3.Content*: development of an e-bibliography of the literature supporting CLABSI prevention *Mode/Delivered to*: physicians and nurses

Intervention	Content of the intervention and modes of delivery to overcome the targeted barriers and enhance the facilitators
	When/how often: at the start of the observation and ongoing 4. *Content*: provision of knowledge test assessment *Mode/Delivered to*: all staff *When/how often*: at 1st and 6th month of the intervention/ twice during the intervention period
Improvements of skills: hands-on training	Content: bedside training; visual instruction booklet Mode/Delivered to: face-to-face; accessible to all nurses When/how often: ad hoc; 3 times for each nurse
Persuasive communication regarding important consequences, to aid implementation of CLABSI practices	Content: message from infection preventionist physicians about the positive consequences when all CLABSI evidence-based practices are implemented Mode/Delivered to: e-mail/all physicians and nurses *When/how often*: once a month
Evaluation of practices	Content: audit of CLABSI preventive practices When/how often: twice weekly
Changes to policies to improve teamwork	1.Content: deputy head nurse had been trained by the infection preventionist physician in audit process; physicians and nurses work together in preparing teaching sessions When/how often: at the start of the observation and Ongoing 2.*Content*: support of champion nurses to present short teaching sessions within the ICU area *Mode/Delivered to*: oral presentations / ICU's nurses *When/how often*: two lectures to be delivered
Feedback	Content: feedback on knowledge test results, performance adherence, CLABSI rates, incidents of non-adherence with CLABSI preventive practices Mode/Delivered to: e-mail (group); written on ICU's white board/physicians and nurses When/how often: twice a month; monthly
Changes in policies to improve leadership: positive feedback and rewarding	Content: medical and ICU nursing directors committed to praise nurses who demonstrated high levels of adherence to CLABSI practices Mode/Delivered to: face-to-face/nurses When/how often: at the start of the observation and ongoing

For example, one identified barrier was lack of comprehensive education in relation to CLASBI prevention. The task force agreed that this barrier would be best addressed by applying multifaceted education, having regard to the local conditions (nurses were not able to leave the ICU area to attend teaching) (Safdar & Abad 2008, Lobo et al. 2010). Therefore, education was delivered through: (a) a teaching session for physicians and the head nurse, (b) group teaching sessions for the nurses within the ICU, (c) a training video provided to trainee physicians, (d) visual instruction cards and (e) promotional documents (a booklet).

Step 3: How can behavioural change be evaluated?

Patient health outcomes (CLABSI rates) and process measures (adherence to requirements for CVC insertion, handling and dressing change) were measured in the intervention period of the study, to assess the intervention's effectiveness regarding CLABSI rates and practitioners' adherence to CLABSI practices. Intention, self-efficacy, attitudes, subjective norms, knowledge and contextual elements (culture, leadership and evaluation of practices) were also measured in the intervention period, to identify whether the intervention had an effect on behavioural and contextual influences

6.4 Summary and conclusion

This chapter illustrates a three-step systematic method, which was followed by the study's task force, for developing a theory-based intervention to change HCWs' behaviour relating to CLABSI prevention. At the start of the process, the task force was formed to establish common ground and a sense of community through fostering opportunities for interaction and communication. The intervention then developed, following a three-step process. Initially, it was agreed that 15 barriers and two facilitators would be addressed through the intervention. This was followed by the identification of components of 11 interventions. These were linked to relevant and effective content and modes of delivery. This chapter demonstrates how a theory-based intervention was developed by non-researchers, considering various data collection methods and especially through observation of the context and tools available in the literature. Moreover, this chapter specifies the content of the intervention and provides a platform for intervention improvement. The following chapter proceeds to discuss the methods used for data collection and analysis in the intervention period of the study. Evaluation of the effectiveness of the intervention is also examined.

PART TWO: IMPLEMENTATION AND EVALUATION OF A THEORY-BASED INTERVENTION INTENDED TO REDUCE CLABSI RATES IN A GREEK MEDICAL ICU

CHAPTER 7: Implementation and evaluation of the intervention

7.1 Introduction

This chapter describes the implementation and evaluation of the intervention of the study. Figure 7.1 shows the study design in the intervention period, and the relationship between the phases of the study and the methods used in each. Firstly, the aim and objectives of the intervention period are presented in this chapter. This is followed by a description of the intervention site, participants, data collection and measurement methods, data analysis procedures and ethical considerations of the study. The tasks and timelines of the intervention are then described. Then, the evaluation of the impact of the intervention on CLABSI rates and process measures are presented. Changes in HCWs' knowledge, behavioural beliefs and perceptions of contextual elements after the implementation of the intervention are examined. Changes related to the actual implementation of the intervention are also presented.

7.2 Aim and objectives

The aim of the intervention period was to implement and evaluate a theory-based intervention relating to CLABSI rates and adherence to CLABSI practices within a medical ICU in Greece. The specific objectives of the intervention period were to:

- Implement the intervention within a single site.
- Evaluate the effects of the intervention on:
- CLABSI rates

Figure 7.1: Overview of study design and the relationship between phases of the study

Pre-baseline period: 6 months

Monthly surveillance of CLABSI rates

Preparatory work before data collection

Obtain approval from King's College Ethics Committee

Gain access from gatekeepers

Recruitment email to research participants

Informative recruitment leaflet describing the aims of the study sent to participating survey ICUs

Baseline period: 4 months

Objectives:

- Identify the behavioural determinants in multiple sites and the contextual influences in a single site
- Establish CLABSI rate and HCWs' adherence to CLABSI preventive practices in a single site

Monthly surveillance of CLABSI rates

Distribution of questionnaires to physicians and nurses

Non-participant observation:

- structured observation of current CLABSI preventive practices (CVC insertion, handling, site care) within the intervention site
- fieldwork in the intervention site

Development of the intervention

Analysis of quantitative and qualitative findings

Intervention period: 6 months

Objectives:

- Implement the intervention in a single site
- Evaluate the effects of the intervention on CLABSI rates, adherence to CLABSI preventive practices, knowledge about CLABSI prevention, contextual and behavioural influences in the implementation of CLABSI preventive practices

Implementation of the intervention

Monthly surveillance of CLABSI rates

Measurement of adherence rates: structured observation of CLABSI preventive practices (CVC insertion, handling, site care)

Distribution of questionnaires to physicians and nurses

Post-intervention period: 6 months

Monthly surveillance of CLABSI rates

- adherence to evidence-based CLABSI preventive practices (CVC insertion, handling and site care)
- knowledge about CLABSI prevention
- contextual influences (culture, leadership and evaluation of practices) and behavioural influences (self-efficacy, attitudes, behavioural beliefs, subjective norms and normative beliefs) in the implementation of evidence-based CLABSI preventive practices

7.3 Design

A prospective uncontrolled, before-and-after design was used to evaluate the intervention of the study.

7.4 Research setting and participants

The intervention was implemented from September 2015 to February 2016 inclusive in a medical ICU (the intervention site). Section 4.4 of Chapter 4 provides a description of the intervention site. Since surveillance of CLABSIs within ICU settings is not mandatory in Greece, the intervention site was selected because it had a continuous surveillance system for CLABSI rates in place since 2012. On account of budget cuts related to the financial crisis, the number of physicians and nurses available to participate in this phase of the study was reduced compared with the baseline period. Consequently, the number of ICU beds was also reduced from ten to six. Eleven physicians and 11 nurses were employed in the intervention site, and the usual patient: nurse ratio was 3:1 during the intervention period of the study. The following section describes the practice context relating to CVC insertion, handling and site care in the ICU prior to the beginning of the intervention.

A CVC trolley (Figure 7.2) containing all the necessary supplies to adhere with sterile procedure for CVC insertion was already in place in the intervention site.

Figure 7.2: CVC trolley

The local procedures for CVC insertion followed standard guidelines, i.e. use of maximal sterile barrier (theatre cap, face mask, sterile body gown, sterile gloves, full-size body sterile drape), skin antisepsis with 2% chlorhexidine in 70% alcohol, and thorough washing of hands with antiseptic solution and water (O'Grady et al. 2011). An individual trolley was available at each bedside to allow nurses to prepare the patient's medication. Each trolley contained a 70% alcohol agent, and there was also easy access for nurses to the unit's sinks. Nurses prepared medications using the surface of each trolley. Moreover, intravenous (IV) drips and syringes were carried in their hands (with clean gloves being worn) to the patient and were placed either on the bed or on the top of the ventilator just prior to accessing the CVC. However, they should have placed these in a tray and not laid them on the bed. Needleless connectors (See, figure 7.3) supplies were not sufficient to ensure that they were available for every port of the CVCs.

Figure 7.3 Needless connector

Thus, needleless connectors were used in combination with three-way taps, which were not replaced every time the catheter was accessed, either because they were not in stock at a particular time or because this was forgotten. When a three-way tap was in place, it was important for the nurses to scrub the port of the catheter's lumen whilst leaving the cap on (See, figure 7.4) instead of removing it, as a result of misconceptions of the term 'hub' in the Greek language. However, the *'scrub the hub'* technique was applied with the correct technique (resembling squeezing an orange See, figure 7.5) and for the correct duration (15-30 seconds) (Lockman et al. 2011, O'Grady et al. 2011). Either transparent adhesive dressings (best practice) or sterile gauzes were used, depending on the unit's monthly budget (transparent adhesive dressings are more expensive compared with sterile gauze).

Figure 7.4: Three-way tap

The white cap must be removed prior to disinfection of the port

Figure 7.5: Scrub the hub technique

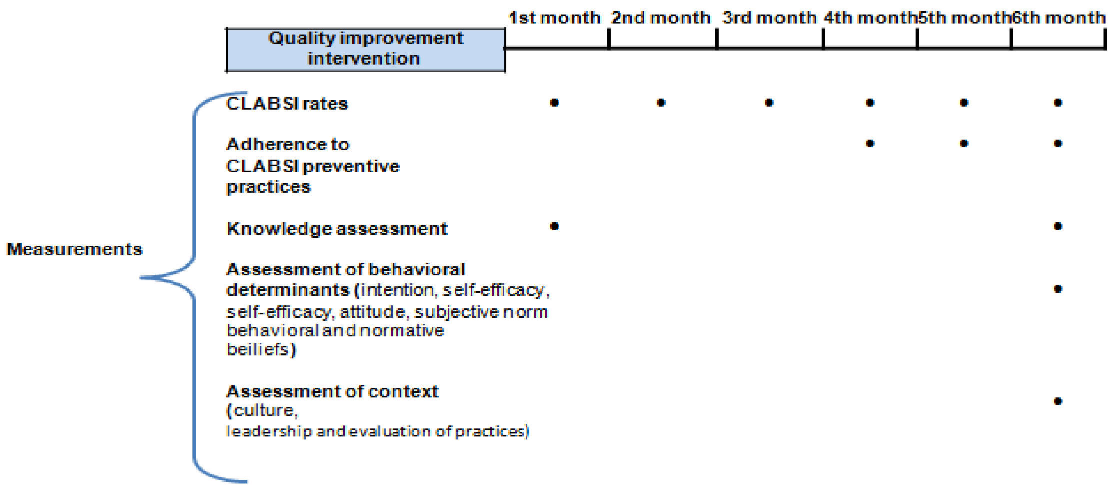
7.5 Data collection methods

The same survey instrument and observation tools as used in the baseline assessment were also used for data collection during the intervention period. They are all fully described in Chapter 4 of the thesis (sections 4.6 and 4.6.2). A self-reported questionnaire was distributed to identify HCWs' knowledge, contextual and behavioural influences. English and Greek versions of the survey questionnaire are included in Appendices 5 and 6. Structured observation was also employed to assess rates of adherence to the evidence-based practices for CVC insertion, handling and site care. A monthly continuous surveillance of CLABSI rates was undertaken during the intervention period (surveillance method is described in Chapter 4, section 4.6.5). The patients' severity of disease (APACHE II), the number of patient days, catheter days, CVC utilisation ratio, time to CLABSI occurrence (days), total number of physicians and nurses and the number of active ICU beds were also reported in the intervention period.

7.5.1 Measurements

Figure 7.6 presents the measurements taken during the six-month intervention period. Monthly collection of data relating to CLABSI rates continued during the six-month post-intervention period.

Figure 7.6: Timeline of measurements in the intervention period



CLABSI rates

CLABSI rates were calculated by dividing the number of new CLABSIs (numerator) by the total number of CVC days, and multiplying the result by 1000.

Adherence rates

Adherence to all elements of the CVC insertion, handling and site care checklist were assessed. Adherence rates for each of these CLABSI practices was calculated by dividing the number of correct practices (numerator) by the total number of observed practices, and multiplying the result by 100, so that the results are expressed as percentages (See, table 7.1).

Table 7.1: Calculation of measurement of CLABSI practices

Measurement	Calculation
Adherence to all evidence-based measures during CVC **insertion**	$\frac{\text{Number of CVC insertions in which all evidence-based measures are implemented}}{\text{Number of observed CVC insertions}} \times 100$
Adherence to all evidence-based measures during CVC **handling**	$\frac{\text{Number of CVC handlings in which all evidence-based measures are implemented}}{\text{Number of observed CVC handlings}} \times 100$
Adherence to all elements of CVC **site care**	$\frac{\text{Number of CVC site care instances in which all evidence-based measures are implemented}}{\text{Number of observed CVC handlings}} \times 100$

Knowledge regarding CLABSI prevention

To assess the effectiveness of the intervention on HCWs' knowledge regarding CLABSI prevention, a ten-question knowledge test (Part A of the survey questionnaire) was distributed to the HCWs at the intervention site. The knowledge test was administered twice (in the first and sixth months of the intervention) to identify the immediate and residual understanding of the HCWs in CLABSI prevention.

Behavioural influences

In order to assess the effectiveness of the intervention on the HCWs' behavioural influences during implementation of the intervention, scales measuring intention, self-efficacy, attitudes, behavioural beliefs, subjective norms and normative beliefs were administered to the HCWs (Parts B, C and D of the survey questionnaire). Behavioural determinants were assessed at the end of the intervention period (at the end of the sixth month).

Contextual influences

In order to assess the effectiveness of the intervention on contextual influences, the Context Assessment Index (CAI) (culture, leadership and evaluation of practices sub-scales) was administered to the HCWs (Part E of the survey questionnaire).

7.5.2 Data analysis

Data from questionnaire survey and structured observation were analyzed using quantitative methods which included both descriptive and inferential statistics. Data were coded and analyzed using the statistical package for social sciences (SPSS), (IBM Corp. Released 2012). Data analysis summary is presented in table 4.8, page 141 of the thesis.

7.5.2.i Descriptive statistics

Nominal level data were described using absolute numbers and percentages while continuous and ordinal level data were described using mean, standard deviation, median and interquartile range.

7.5.2.ii Inferential statistics

Data were analyzed using both parametric and non-parametric methods. The Kolmogorov-Smirnov test and graphs (histograms and normal Q-Q plots) were used to test continuous variables for normality. Normative beliefs total score did not conform to a normal distribution whereas all the other scale scores did.

Independent t-test or Mann-Whitney U-test were used to compare scores between groups (e.g. nurses and physicians, before and after intervention). The Mann-Whitney U test was used if the data were not normally distributed (e.g. normative beliefs). Spearman's (r_s) or Pearson's correlation coefficient (r) were used to measure the association between continuous variables. Spearman's was used for associations involving normative beliefs. Chi-square test (χ^2) and Fisher's exact test were used to test for association between two nominal/categorical variables (e.g. adherence in the baseline and intervention periods).

The CLABSI data were analyzed using a Poisson generalized linear model with number of cases specified as the dependent variable, log of central line days as an offset (to allow modeling of CLABSI rates), period (*pre-baseline*, *baseline*, *intervention* and *post-intervention*) as an independent categorical variable with a covariance structure that was *scaled identity* when testing whether within period linear (t) and quadratic effects (t^2) differed between periods and *first-order autoregressive* (correlations strongest for adjacent time-points and lessening as time-points become wider apart) when comparing overall rates between periods. Model F-tests were used for the purpose of statistical testing. The F-statistic, numerator and denominator degrees of freedom and p-values have been reported. Pair-wise tests between periods were conducted using the sequential Bonferroni method which adjusts for multiple comparisons. The modeling was performed using the SPSS procedure GENLINMIXED. All tests of statistical significance were two-tailed. The convention of using probability values (p) less than 0.05 (Type I error) to indicate statistical significance was adopted.

7.6 Ethical considerations

As previously mentioned, ethical approval for the study was granted by the Ethics Committee of King's College, London, UK (CREC-PNM/13/14/14-78). The research and scientific advisory board of the intervention hospital gave access permission to both the baseline and the intervention period since the baseline period HCWs in the intervention site had already provided their written consent to participate in both phases of the study. Additionally, every new member of staff was approached by the researcher on the day of their arrival at the intervention site. They were explicitly informed about the purpose, methods and intended possible uses of the research, what their participation would involve, the likely risks (if any) and the benefits that could result. Participants were informed that their participation was voluntary, and that it was their right to withdraw from the study at any time without giving a reason and without penalty. Participants were assured that the data from the questionnaires provided would be anonymous. It was also explained to the participants that findings from the structured observation remained confidential, while no other identifying data would be collected from them. Nevertheless, it was made clear to the new participants that if, during the observation, the researcher identified practices that might harm patients' safety, she was authorized by the medical director of the intervention ICU to report the incidents to the medical and nursing director of the research ICU. Moreover, participants were assured that all data were stored by the researcher in a locked filing cabinet and on a password, firewall protected and encrypted computer. The above information was explicitly provided in a written form (See, Appendix 11) and a separate consent form was signed by them (See, Appendix 12). The return of the questionnaire would constitute the participants' consent to complete the survey questionnaire undertaken during the intervention period.

7.7 Timeline of the intervention

Between September 1, 2015 and February 29, 2016, a theory-based intervention was implemented in a medical ICU (the intervention site). The content of the intervention (see Chapter 6) drew on behavioural and contextual barriers and facilitators that had been identified in the baseline period of the study. The tasks and timelines for implementing the intervention of the study are presented in Table 7.2.

In summarizing the previous section, the design and the methods used to implement the intervention during a six-month period (September 2015 to February 2016 inclusive) was described. The same survey questionnaire as that used in the

Table 7.2: Timeline and components of the intervention period of the study

COMPONENTS OF THE INTERVENTION	SEPTEMBER 2015				OCTOBER 2015				NOVEMBER 2015				DECEMBER 2015				JANUARY 2015				FEBRUARY 2015			
	W1	W2	W3	W4	W1	W2	W3	W4	W1	W2	W3	W4	W1	W2	W3	W4	W1	W2	W3	W4	W1	W2	W3	W4
Enviromental changes to aid implementation																								
Electronic and printed documents: CLABSI prevention bundles, guidelines and other current literature		●																						
Educational material:																								
visual card including the required equipment for CVC insertion		●																						
A-3 size booklet describing the correct & wrong answers in the knowledge test	●																							
visual card: necessary steps for Aseptic-Non-Touch-Technique			●																					
booklet explaining Aseptic-Non-Touch-Technique			●																					
purchase of trays for IV medication administartion					●																			
Training of deputy head nurse in audit processes																	●							
Maintenance of adequate supplies for CLABSI prevention	on going																							
White board dedicated to CLABSI prevention was placed within the intervention site	●																							
Education-Skills																								
Teaching session on correct and wrong answers of the knowledge test	● physicians																							
Discussions with nurse about the knowledge test's correct and wrong answers within the ICU area	● nurses																							
Demonstration of a video on CVC insertion	it was shown every time new residents start a 3-month training in the ICU																							
Bed side training of nurses in Aseptic Non Touch Technique										●														
Provision of a knowledge on CLABSI prevention					●																		●	

Table 7.2: Timeline and components of the intervention period of the study (*cont'd*)

COMPONENTS OF THE INTERVENTION	SEPTEMBER 2015				OCTOBER 2015				NOVEMBER 2015				DECEMBER 2015				JANUARY 2015				FEBRUARY 2015			
	W1	W2	W3	W4	W1	W2	W3	W4	W1	W2	W3	W4	W1	W2	W3	W4	W1	W2	W3	W4	W1	W2	W3	W4
Evaluation of practices																								
Audit of CLABSI practices													●											
Team work-Leadership																								
Infection preventionist physician work together with deputy head nurse in audit processes																			●					
Nurses attend teaching sessions within the ICU																								
Champion nurses presented two teaching sessions														●							●			
Social support																								
Medical and nurse directors praise nurses who demonstrate high adherence with CLABSI practices									●															
Feedback																								
Dissemination of baseline findings	●																							
Monthly feedback of unit's CLABSI rates				●				●				●				●				●				●
Adherence with CLABSI practices																●		●		●		●		
Incidents of non-compliance																●		●		●		●		
Results from the knoweldge test							●																	●
Reminders																								
Visual cards		●																						
Visual stickers to remind to the staff to wear gloves and the scrub-the -hub practice		●																						
Visual stickers with intervention's logo next to ICU's sinks		●																						
Persuasive communication on important consequences to aid implementation of CLABSI practices																								
Infection preventionist physician emailed every month relevant emails to all staff					●					●					●				●			●		

baseline period was distributed to 22 HCWs employed at the intervention site. The questionnaire assessed behavioural and contextual influences and was distributed at the end of the intervention (at the end of the sixth month). The HCWs' knowledge regarding CLABSI prevention was assessed through a knowledge test twice (during the first and sixth months) during the intervention. The same observation checklists as those used in the baseline assessment, describing the evidence-based CLABSI preventive measures, were used for assessing HCWs' adherence to these practices during the intervention period. The tasks and timelines for the intervention were also presented. The next section presents the findings from the evaluation of the intervention.

7.8 Results of the evaluation of the intervention

7.8.1 Demographic characteristics of participants at the intervention site

The total HCW population of the intervention site over the duration of the intervention period was 11 physicians and 11 nurses. All participants returned the completed questionnaire – a response rate of 100%. The demographic characteristics of the HCWs at the intervention site between the baseline and intervention period are presented in Table 7.3.

Table 7.3: Demographic characteristics of 22 participants employed at the intervention site in the intervention period

	Baseline period		**Intervention period**	
	Nurses (n=20)	***Physicians (n=17)***	***Nurses (n=11)***	***Physicians (n=11)***
	N (%)	**N (%)**	**N (%)**	**N (%)**
Gender (%)				
Female	16 (80.0)	11 (64.7)	5 (62.5) ł	8 (80.0) ł
Male	4 (20.0)	6 (35.3)	3 (37.5) ł	2 (20.0) ł
Age *(years), mean (SD)*	35.0 (7.3)	40.9 (7.1)	39.4 (7.5)	46.6 (6.9)
ICU work experience *(years), median (IQR)*	4.0(2.3-4.9)	2.0 (0.2-8.4)	3.0 (2.5-7.0)	8.5 (3.0-19.0)
Appointment level *for physicians*				
Consultant		2 (11.8)		2 (22.2) ł
Resident		7 (41.2)		4 (44.4) ł
Fellow		8 (47.1)		3 (33.3) ł
Appointment level *for nurses*				
Nurse Manager-Deputy Manager	0 (0.0)		0 (0.0)	
Staff nurse	20 (100.0)		11 (100.0)	
Post academic studies				
Medical specialty		5 (29.4)		2 (20.0)
Specialty in critical care medicine		5 (29.4)		8 (80.0)
MSc		3 (17.6)		2 (18.2)
PhD		8 (47.1)		6 (54.5)
Specialty in medical/surgical nursing	3 (15.0)		5 (45.5)	
Specialty in critical care nursing MSc	7 (35.0)		0 (0.0)	
PhD	4 (20.0)		6 (54.5)	
	1 (5.0)		1 (0.09)	

SD: standard deviation, IQR: interquartile range, ł: questions were not responded to by all physicians and nurses

The mean age of the physicians was 46.6 years (SD=6.9 years), and for nurses 39.4 years (SD=7.5 years). The majority of respondents were females (n=13, 59%). The median length of working experience was 8.5 years for the physicians and 3.0 years for the nurses. Almost one third of the physicians (n=5, 29.4%) had an intensive care medicine specialty and more than 50% of them (n=6) held a PhD. Nearly 50% of nurses (n=5) had had post-registration training, while more than half (n=6, 54.5%) held a master's degree. One of the nurses held a PhD.

Over the intervention period fewer physicians and nurses worked at the intervention site. All nurses possessing the critical care nursing specialty and had participated at baseline were no longer working in the unit during the intervention period. A greater number of physicians with ITU experience worked during intervention period than the baseline period.

7.9 Incidence density of CLABSIs

A comparison of CLABSI rates was made between the pre-baseline, baseline, intervention and post-intervention phases of the study. The incidence rate was defined as the number of CLABSI cases per 1000 CVC days. The means of CLABSI rates during the above periods are presented in table 7.4.

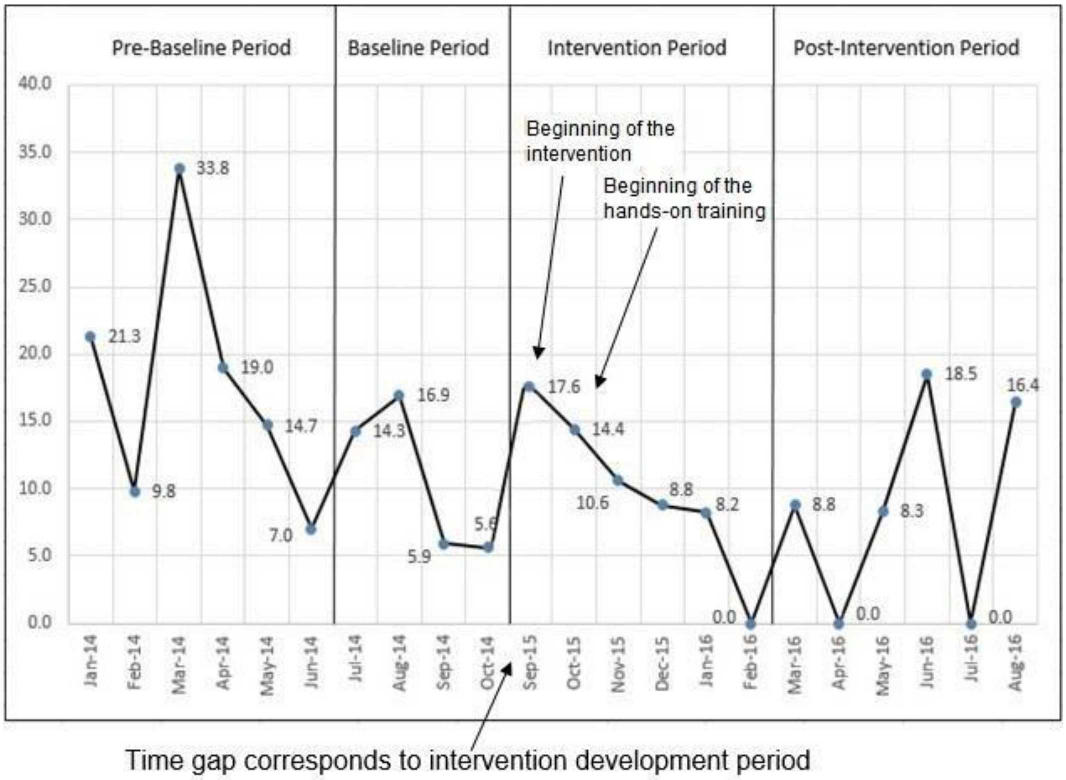
Table 7.4: CLABSI rates estimated by the model

	Rate[1]	(95% CI)
Pre-baseline	18.7	(13.3-26.1)
Baseline	10.5	(5.7-19.3)
Intervention	10.6	(6.0-18.9)
Post-intervention	8.7	(4.5-17.1)

[1] Rate per 1000 central line days

For each phase, the total CLABSI incidence density rate was calculated as the mean of monthly CLABSI incidence rates. Figure 7.7 presents the monthly CLABSI incidence rate during the above periods.

Figure 7.7: Monthly CLABSI rates per 1000 days based on data from the intervention site



Linear (F [3, 14] = 1.549, p=.25) and quadratic (F [3, 10] = 0.258, p=.85) effects within the four periods did not vary significantly between the periods (Figure 8.1). In the combined pre-baseline and baseline period there was some evidence of a downward linear trend in rates (βlin = -0.114, SE (βlin) = 0.056, p= .077). During the combined intervention and post-intervention period a quadratic function provided the best fit (βlin = -0.482, SE (βlin) = 0.202, p = .041, βquad = 0.035, SE (βquad) = 0.016, p = .051). There was some variability between the four study periods (F [3,18] = 2.480, p=.094) although this did not achieve statistical significance. A sequential Bonferroni analysis found no pair-wise differences between the periods. The estimated marginal means for the model (Table 7.4) suggest that CLABSI rates were highest during the pre-baseline period but did not vary noticeably between the other three periods. CLABSI and unit's characteristics during the intervention period are presented in table 7.5.

Table 7.5: Patient and intervention site characteristics in baseline and intervention period

	Baseline period: July 2014-October 2014	Intervention period September 2015 - February 2016
Total patient admissions	47	45
Mean APACHE II score (SD)	21.4 (±8)	21.7 (±8)
Patient days	691	822
Catheter-days	665	745
CVC usage ratio	96.2%	90.6%
Time to CLABSI occurrence (days)	13.8	11.6
Total number of physicians (n)	17	11
Total number of nurses (n)	20	11
Active ICU beds (n)	10	6

7.10 Results from structured observation of CLABSI preventive practices

Twenty-three (n=23) CVC insertion, 76 (n=76) CVC handling and 22 (n=22) CVC site care practices were observed during the intervention period. The structured observation process is described in Chapter 4, Section 4.6.3. Table 7.6a demonstrates the comparison of total rates of adherence to CLABSI preventive measures, for CVC insertion, handling and site care, between the baseline and intervention period. Total adherence to preventive measures for CVC handling performed by nurses was significant higher in the intervention period ($p<0.0001$), although it remained suboptimal (65.7%). Excellent adherence (≥95%) was observed for CVC insertion practice during both periods.

Table 7.6a: Total adherence to CVC insertion, handling and site care during baseline and intervention periods

	Baseline period Correct practices/observed practices	**Intervention period** Correct practices/observed practices	***P-value*[a]**
Physicians **Insertion (%)** Total adherence (*all-or-none –measure*)	31/32 (97.0)	23/23 (100.0)	0.406[a]
Nurses **Handling *(%)*** Total adherence (*all-or-none –measure*)	9/79 (11.8)	50/76 (65.7)	<0.001[b]
Site care (%) Total adherence (*all-or-none –measure*)	14/18 (77.8)	21/22 (95.4)	0.099[a]

[a] Fisher's exact test [b] chi-squared test

Table 7.6b presents the changes in adherence rates to the individual CLABSI bundle elements for CVC insertion, handling and site care between the baseline period and four periods over which observations of these practices were performed during the intervention phase. Adherence to the 'donning clean gloves' element of CVC handling practice significantly deteriorated over time (p=0.021). Adherence to 'maintaining Aseptic Non-Touch Technique', 'scrub the hub' and 'accessing the CVC only with sterile devices' elements of CVC handling practice were improved significantly over time (p<0.0001, p<0.0026, p<0.0254 respectively).

Table 7.6b: Adherence to individual elements of CVC insertion, handling and site care practices throughout baseline period and intervention period (four periods)

	Baseline period	Intervention period				*P-value*[a]
		7 Dec-20 Dec 2015	21 Dec-3 Jan 2016	4 Jan-17 Jan 2016	25 Jan-14 Feb 2016	
Insertion, n (%)	Correct practices/observed practices	Correct practices/observed practices	Correct practices/observed practices	Correct practices/observed practices	Correct practices/observed practices	
Hand hygiene	32/32 (100.0)	8/8 (100.0)	1/1 (100.0)	8/8 (100.0)	6/6 (100.0)	1.000
Skin disinfection with chlorhexidine 2%	31/32 (96.8)	8/8 (100.0)	1/1 (100.0)	8/8 (100.0)	6/6 (100.0)	0.469
Maximal barrier precautions	32/32 (100.0)	8/8 (100.0)	1/1 (100.0)	8/8 (100.0)	6/6 (100.0)	1.000
Skin disinfection agent completely dry at time of first skin puncture	32/32 (100.0)	8/8 (100.0)	1/1 (100.0)	8/8 (100.0)	6/6 (100.0)	1.000
Handling, n (%)						
Hand hygiene	68/79 (86.0)	23/24 (95.8)	17/17 (100.0)	17/18 (94.4)	16/17 (94.1)	0.106
Donning of clean gloves	76/79 (96.2)	20/24 (83.3)	16/17 (94.1)	16/18 (88.8)	13/17 (76.5)	**0.021**
Maintaining Aseptic-Non-Touch Technique	14/79 (17.7)	15/24 (62.5)	11/17 (64.7)	13/18 (72.2)	12/17 (70.6)	**<0.0001**
Scrub the hub	64/79 (81.0)	23/24 (95.8)	16/17 (94.1)	18/18 (100.0)	17/17 (100.0)	**0.0026**
Accessing the CVC only with sterile devices	69/76 (91.0)	24/24 (100.0)	17/17 (100.0)	18/18 (100.0)	17/17 (100.0)	**0.0254**
Dressing replacement, n (%)						
Hand hygiene	14/18 (78.0)	5/5 (100.0)	7/7 (100.0)	5/5 (100.0)	5/5 (100.0)	**0.051**
Clean/sterile gloves	18/18 (100.0)	5/5 (100.0)	7/7 (100.0)	5/5 (100.0)	5/5 (100.0)	1.000
Skin disinfection with aseptic technique	18/18 (100.0)	5/5 (100.0)	7/7 (100.0)	5/5 (100.0)	5/5 (100.0)	1.000
Apply sterile dressing with aseptic technique	18/18 (100.0)	5/5 (100.0)	7/7 (100.0)	5/5 (100.0)	5/5 (100.0)	1.000
Aseptic technique was maintained	18/18 (100.0)	5/5 (100.0)	7/7 (100.0)	4/5 (80.0)	5/5 (100.0)	0.252

[a] Cochran-Armitage trend test

7.11 Knowledge test

Physicians and nurses were asked to score themselves on a ten-question multiple-choice, self-completed knowledge test in the first and sixth months of the intervention period. Each correct answer was scored one point and an incorrect answer was allocated no score; the maximum possible score was 10 points and the minimum 0 points. Table 7.7a compares the mean scores on ten questions for the total sample of HCWs, between the baseline and the first- and sixth- month administrations during the intervention period, and also between the first-and sixth - month administrations in the intervention period.

Table 7.7a: Mean scores on ten questions of knowledge test between baseline period and two administrations in the intervention period

	Mean	SD[a]	Test statistic	Degrees of freedom	*P*-value[b]
Baseline period Total sample (n=37)	5.1	1.9	5.31	59	<0.001
Intervention period: 1st month Total sample (n=22)	7.8	2.0			
Baseline period Total sample (n=37)	5.1	1.9	6.09	57	<0.001
Intervention period: 6th month Total sample (n=22)	8.1	1.7			
Intervention period: 1st month Total sample (n=22)	7.8	2.0	0.55	44	0.582
Intervention period: 6th month Total sample (n=22)	8.1	1.7			

[a] standard deviation
[b] student's t-test

Table 7.7b presents the knowledge test and shows the percentages of physicians and nurses who chose each response for both administrations during the intervention period. Scores in the knowledge test were significantly improved in the total sample of the HCWs between the baseline period and in both administrations during the intervention period ($p<0.001$). The lowest percentages of correct answers for physicians and nurses were found in the question about to the use of an antibiotic ointment at the insertion site in both administrations (Q2: at first month 66.7%, 42.9%, for nurses and physicians respectively and at the sixth month 63.6% and 45.5%, for nurses and physicians respectively). Questions related to administration of lipid emulsions, frequency of central line and transducer replacement, and frequency of replacement of a central line over a guidewire were scored correctly by all nurses responding to questionnaires distributed in the first month and the sixth month of the intervention period.

Table 7.7b: Percentage of correct answers of knowledge test by professional group at 1st and 6th month of intervention period

Items	Intervention period (at 1st month)		Intervention period (at 6th month)	
	Nurses (n=11)	***Physicians (n=11)***	***Nurses (n=11)***	***Physicians (n=11)***
	Percentage of correct answers %	Percentage of correct answers %	Percentage of correct answers **%**	Percentage of correct answers **%**
It is recommended to disinfect the catheter insertion site with: a. 2% aqueous chlorhexidine b. 0.5% alcoholic chlorhexidine c. 10% povidone-iodine d. I do not know	91.7	57.1	90.9	72.7
It is recommended to apply an antibiotic ointment at the insertion site of a CL: a. Yes, because it decreases the risk for CLABSIs b. No, because it causes antibiotic resistance c. No, because it does not decrease the risk for catheter-related infections d. I do not know	66.7	42.9	63.6	45.5
When lipid emulsions are administered through a CL it is recommended to replace the administration set: a. Within 24 hours b. Every 72 hours c. Every 96 hours d. I do not know	91.7	78.6	90.0	90.9
When neither lipid emulsions nor blood products are administered through a CL it is recommended to replace the administration set: a. Every 24 hours b. Every 48 hours c. Every 96 hours d. I do not know	100.0	71.4	100.0	72.7
It is recommended to replace CLs routinely: a. Yes, every 7 days b. Yes, every 3 weeks c. No, only when indicated d. I do not know	100.0	92.9	100.0	100.0
It is recommended to replace CLs over a guidewire: a. Yes, every 3 days b. Yes, every 7 days c. No, only when indicated d. I do not know	100.0	92.9	100.0	100.0
It is recommended to replace pressure transducers and tubing routinely: a. Yes, every 4 days b. Yes, every 8 days c. No, only when indicated d. I do not know	100.0	71.4	100.0	81.8
In settings with a high rate of catheter-associated infections it is recommended to use a CL coated or impregnated with an antiseptic agent: a. Yes, in patients whose CL is expected to remain in place for more than 5 days b. No, because the use of such catheters is not cost-effective c. No, because the use of such catheters does not ensure a significant decrease in the rate of CLABSIs d. I do not know	41.7	57.1	36.4	63.6
It is recommended to change the dressing on the catheter insertion site: a. On a daily basis b. Every three days c. When indicated (soiled, loosened etc) and every 2 days for gauze dressings and at least weekly for transparent dressings d. I do not know	91.7	92.9	90.9	90.9
It is recommended to cover up the catheter insertion site with: a. Polyurethane dressing (transparent, semi-permeable) b. Gauze dressing c. Both are recommended because the type of dressing does not affect the risk of CLABSIs d. I do not know	83.3	50.0	81.8	54.5

Text highlighted in blue colour indicates the correct answer and the percentages of correct answers

7.12 Context Assessment Index (CAI)

All participants were asked to rate themselves on a 37-item, four-point, Likert-type scale ranging from 1 (‘strongly agree’) to 4 (‘strongly disagree’). The score in CAI ranges from 25% to 100% (from weak to strong context). Scoring of CAI is described in Chapter 4, Section 4.6, *Part E*. The items address HCWs’ perceptions about their organisation’s readiness to implement evidence-based practice. The mean values of the CAI total score, and the mean values of the sub-scales (culture, leadership and evaluation of practices) in the total sample of physicians (n=11) and nurses (n=11), are presented in Table 7.8.

Nurses perceived significantly higher the culture, leadership, evaluation of practices and the total CAI (p=0.001, p=0.001, p=0.003, p=0.001 respectively) compared with the baseline period. For physicians the sub-scales and total CAI did not differ between baseline and intervention. The total sample of physicians and nurses scored significantly higher only in the culture sub-scale (p=0.03) compared with the baseline period. Descriptive statistics of each item in the culture, leadership and evaluation of practices sub-scales, according to mean for physicians and nurses between the baseline and the intervention period, are presented in Appendix 24.

Table 7.8: Comparisons of CAI scores between baseline and intervention period (total sample, physicians and nurses)

	Total score of culture Mean (SD[a])	Test statistic (Degrees of freedom)	P-value[a]	Total score of leadership Mean (SD[a])	Test statistic (Degrees of freedom)	P-value[a]	Total score of evaluation of practices Mean (SD[a])	Test statistic (Degrees of freedom)	P-value[a]	Total score of CAI Mean (SD[a])	Test statistic (Degrees of freedom)	P-value[a]
Baseline period Total sample (n=37)	68.0 (12.9)	2.2 (57)	0.03	65.0 (13.8)	1.5 (57)	0.15	70.4 (10.6)	1.7	0.08	67.8 (11.7)	0.06 (57)	0.9
Intervention period **Total sample (n=22)**	74.7 (7.7)			69.9 (10.2)			75.3 (10.1)			73.3 (8.5)		
Baseline period Physicians (n=17)	76.0 (10.0)	0.4 (26)	0.72	76.2 (8.7)	1.6 (26)	0.11	76.1 (9.7)	0.6 (26)	0.73	76.1 (8.9)	0.9 (26)	0.39
Intervention period Physicians (n=11)	74.7 (8.5)			70.7 (8.9)			73.7 (10.1)			73.1 (8.6)		
Baseline period Nurses (n=20)	61.3 (11.3)	3.5 (29)	0.001	55.5 (9.5)	3.5 (29)	0.001	65.5 (8.8)	3.3 (29)	0.003	60.8 (9.0)	3.8 (29)	0.001
Intervention period Nurses (n=11)	74.7 (7.3)			69.1 (11.2)			76.9 (10.3)			73.6 (8.8)		

[a] standard deviation [b] Student's t-test

7.13 Behavioural determinants of the participants

Table 7.9 presents the mean values for self-efficacy, attitudes, behavioural beliefs, subjective norms and normative beliefs for the total sample of physicians and nurses between the baseline and the intervention period. The description and scoring of these scales are presented in Chapter 4, Section 4.6 of this thesis.

Physicians and nurses scored significantly higher ($p<0.001$) on the behavioural beliefs scale between the baseline and the intervention period, suggesting that communication about the positive consequences of performing the evidence-based CLABSI preventive measures was effective. However, physicians' and nurses' attitudes did not change over this same period ($p=0.94$).

Table 7.9: self-efficacy, attitudes, behavioural beliefs, subjective norms and normative beliefs in total sample of physicians and nurses between baseline and intervention period

	Baseline period total sample (n=37)	Intervention period total sample (n=22)	Test statistic	*P*-value
	Mean (SD[a])	Mean (SD[a])		
Self-efficacy	5.0 (1.3)	5.3 (1.1)	0.91[b]	0.29
Attitude	6.2 (1.0)	6.2 (1.2)	0.00[b]	0.94
Behavioural beliefs	97.9 (26.7)	119.6 (17.6)	3.39[b]	0.001
Subjective norms	6.2 (0.9)	6.3 (0.8)	0.43[b]	0.504
Normative beliefs	Median (IQR) 12.0 (23.5)	Median (IQR) 20.5 (22.75)	298[c]	0.086

[a] Standard deviation [b] t-test [c] Mann-Whitney

7.14 Resources used for implementing the intervention

An intervention, based on identified behavioural determinants and contextual influences, was developed in this study to reduce CLABSI rates and improve rates of adherence to CLABSI preventive measures. The intervention was undertaken over a six-month period and included the formation of a task force and a series of components that are described in Chapter 6 of this thesis. The following section describes the details of what was delivered in reality.

Task force

The task force met four times to develop the intervention. Eight task force meetings were also held over the course of the intervention to ensure that the components were implemented according to the plan. Prior to each meeting an agenda was sent by the researcher to all members by email. Additionally, minutes from each meeting were kept, and were then communicated by email to the task force members.

Environmental changes to aid implementation

A range of printed training material was developed to aid physicians and nurses in retaining their knowledge of CLABSI preventive measures (See, Appendix 25). The printed material cost approximately 600 euros, funded by Biokon S.A.

Plastic trays were purchased to ensure that nurses maintained the Aseptic Non-Touch Technique during the preparation of IV medication. This equipment cost approximately 20 euros. A white board (See, Figure 7.8) was also purchased; this was placed centrally in the ICU area, enabling the task force members to convey information and messages to staff regarding CLABSIs. The board cost approximately 25 euros, funded by Biokon S.A.

Figure 7.8: The white board placed within the ICU area

The ICU nurse manager ensured, through the logistics department of the hospital, the provision to the intervention site of adequate supplies of all equipment related to CLABSI prevention – for example, needle-less connectors, three-way taps and IV pump sets.

Education and skills

A PowerPoint interactive session was provided to all physicians and to the medical and nurse manager of the unit. All correct and incorrect answers from the knowledge test were presented and discussed. Additionally, all evidence related to each question was shown to the audience. The same session was also provided to the nurses; however, it was repeated four times for groups of nurses to ensure that all nurses could attend it. The sessions took place within the ICU area, and the content of the PowerPoint presentation was printed in an A3 size booklet to ensure that the nursing audience could have visual contact with it. The infection preventionist physician of the intervention developed a training video demonstrating CVC insertion practice. It was ensured that this video was shown to each trainee physician at the beginning of his/her rotation training in the ICU.

All unit nurses, and the ICU nurse manager, were trained by the researcher in the Aseptic Non-Touch Technique three times each, at the bedside. During this training all questions from the staff were answered and discussed. Moreover, all questions and answers were placed in an e-folder under the title Frequently Asked Questions (FAQ). The aim of this was for every nurse to be informed of how the Aseptic Non-Touch Technique is implemented in a variety of clinical cases – for example, during a patient's transport for a diagnostic examination.

A knowledge test was administered twice (in the first and sixth months of the intervention) to all physicians and nurses, in order to evaluate their knowledge regarding CLABSI prevention.

Evaluation of practices

An audit of CLABSI preventive practices commenced as soon as the education and hands-on-training were completed. The deputy head nurse was also trained by the researcher in the observation of CLABSI practices, with the aim of continuing the audit practice after the researcher's departure from the intervention site.

Team work and leadership

The infection preventionist physician (a member of the task force) stated that he should collaborate with a nurse to meet the requirements of the audit process. However, because the deputy nurse manager was not allocated a patient during her shift, it seemed clear that she was the most appropriate individual, in terms of experience and availability, to lead the audit process.

Training was provided to nurses within the ICU environment, since the number of nurses allocated to each shift did not allow them to attend training sessions in the unit's teaching room. Two frontline nurses prepared two 10-minute teaching sessions. The topic for each session was related to the subject of these nurses' MSc and participation was voluntary. All unit's physicians and nurses wore badges displaying the logo of the intervention (Figure 7.9)

Figure 7.9: Badges with intervention's logo worn by the staff of the intervention site

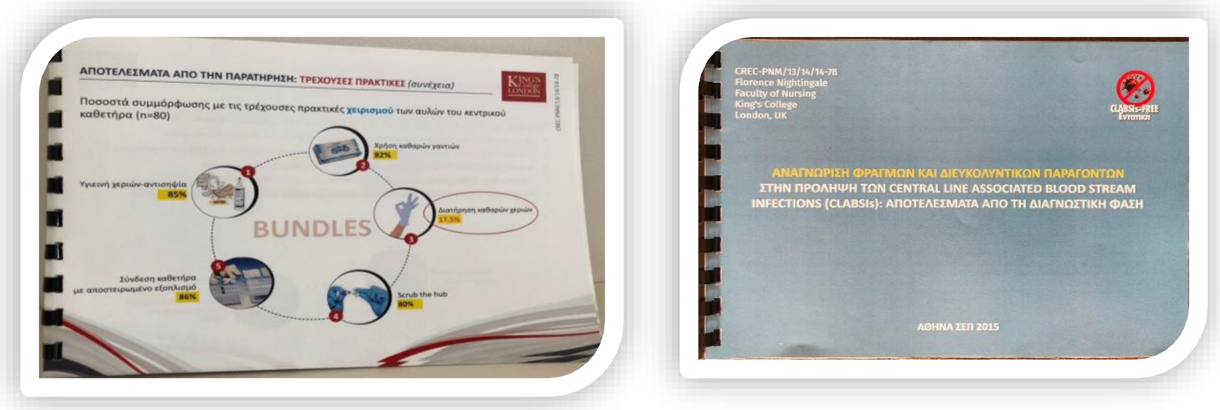
Positive reaction from the medical director and nurse manager of the unit

The nurse manager verbally praised nurses who consistently achieved excellent performance standards in implementing CLABSI preventive practices. Additionally, nurses were rewarded with encouraging phrases, such as *'you are all doing* *wonderful work, thank you all'*, that were written in the daily handover book. The medical director left messages for nurses on the white board, such as *'nurses are the guardian angels of our unit'.*

<u>Feedback</u>

Baseline findings were provided to all staff through a printed booklet that was given to each member (Figure 7.10)

Figure 7.10: Booklet describing the findings from baseline assessment



Data regarding current CLABSI rates were sent to all physicians and nurses during the study process via monthly e-mails. Six e-mails were sent by the infection preventionist physician to all staff. Results from the knowledge tests were provided to all staff via two e-mails. Adherence rates were sent to all staff via e-mails. Pictures demonstrating the implementation of correct practices towards CLABSI (See, Appendix 26) were also included in these emails. Four related e-mails were sent to all ICU staff.

Reminders

Two visual reminder cards and stickers were developed to remind the staff of (a) the Aseptic Non-Touch Technique, (b) the required equipment for the CVC insertion practice, (c) the use of clean gloves, and (d) the 'scrub the hub' practice (Figure 7.11).

Figure 7.11: Visual reminders

Communication regarding significant outcomes to encourage implementation of CLABSI preventive practices

The infection preventionist physician communicated regularly to all staff regarding the importance of implementing all CLABSI preventive practices. For example, *'this month we had x (number of) fewer infections which corresponded to reducing patients' length of stay and cost for our unit'.* Six related e-mails were sent to all ICU staff during the period of the intervention.

With regard to CLABSI preventive practices, the intervention principally targeted the CVC handling practice. CVC insertion practice had already been implemented at the intervention site according to the guidelines, and adherence to CVC site care practice was nearly optimal at the baseline. Other practices, not targeted by the intervention, were also altered during the course of the intervention as a result of the staff's changing mindset toward infection control and prevention. These are presented in Table 7.10.

Table 7.10: Observed changes in practices during the intervention period other than the ones addressed by the intervention

Observed changes
1. Audit of hand hygiene was commenced four months after the beginning of the intervention
2. A baseline assessment form related to the ICU's hand hygiene status was sent to the World Health Organization database (2015)
3. A new suture technique for fastening the CVC (mainly placed in the internal jugular vein) was introduced, to ensure that the catheter was not pulled down by its weight (which could have resulted in the adhesive dressing not efficiently protecting the insertion site)
4. A new method to prepare the total parenteral nutrition infuscate was initiated, to avoid (for example) nutrients and vitamins needing to be administered through the lipid bag
5. Preparation of the hemofiltration bags was made on a dedicated trolley using the Aseptic Non-Touch Technique

Overall the intervention cost approximately 600 euros. The time allocated for the development of the intervention and its implementation was not estimated. Forty-three e-mails were sent to the ICU staff during the intervention to inform them of its progress. Equipment was purchased and printed material to aid implementation was also developed.

7.15 Summary of the results

This chapter presented findings from the evaluation of an uncontrolled, before-and-after study undertaken in a medical ICU. A theory-based intervention was implemented during a six-month period, which aimed to assess whether it had an effect on CLABSI rates and adherence to CLABSI evidence-based preventive measures. The effectiveness of the intervention on HCWs' knowledge of CLABSI prevention, their behavioural beliefs, and perceptions about the ICU's readiness to implement evidence-based practice, were also evaluated.

CLABSI rates were assessed before the baseline, and during the baseline, intervention and post-intervention periods. CLABSI rates were the highest before the baseline assessment. However, the intervention did not achieve a noticeable effect on CLABSI rates during the intervention and post-intervention periods, suggesting that other factors may have not allowed the observation of lower CLABSI incidence after the implementation of the intervention. Improvement of total adherence to CLABSI preventive practices was demonstrated among nurses in respect of CVC handling practice; however, it remained suboptimal (<80%). Maintenance of the Aseptic Non-Touch Technique before nurses accessed a CVC was also largely improved, indicating the effectiveness of nurses' hands-on training regarding this practice. Nevertheless, the results suggest that further improvement would be achieved if the intervention had lasted for a longer period.

Scores in the CLABSI prevention knowledge test, that was provided twice to physicians and nurses over the course of the intervention, improved at both administrations. This indicates the effectiveness of the comprehensive education that was provided as a part of the intervention. The perceptions of physicians and nurses about the unit's culture were improved. Moreover, leadership and evaluation of practices were perceived as higher among nurses at the end of the intervention. These results suggest that an intervention, which has tackled contextual barriers that existed prior to its implementation, can improve an ICU's mindset regarding infection control and prevention. The findings also showed that physicians' and nurses' beliefs, that implementing CLABSI preventive measures will lead to mostly positive outcomes, were strengthened after the intervention. However, their attitudes did not change, perhaps indicating that messages about the positive consequences of the implementation of CLABSI preventive practices to the HCWs should be reinforced.

Overall, the intervention appeared to have successfully achieved its objectives with regards to adherence to CVC handling, HCWs knowledge on CLABSI prevention, nurses' perceptions on culture leadership, evaluation of practices within their working environment and HCWs beliefs on positive outcomes after implementation of CLABSI preventive practices. The next chapter proceeds to critically examine the findings from the baseline and intervention periods in relation to the wider literature on CLABSI prevention and the QI interventions aiming to prevent CLABSIs.

Chapter 8: Discussion

8.1 Introduction

This is the first study which has assessed behaviour and context in parallel, moving towards a better understanding of behavioural determinants and implementation of CLABSI preventive practices. The study provides evidence about the effectiveness of a multifaceted intervention concerning CLABSI prevention within a challenging ICU context. In this uncertain context, adherence to CVC handling practices significantly improved and excellent adherence to CVC insertion practices and CVC site care was maintained. Additionally, important contextual drivers toward effective CLABSI prevention were perceived higher compared to baseline by ICU nurses, and HCWs' knowledge of CLABSI prevention improved after the intervention. However, the study did not reduce CLABSI rates within the six- month intervention period. Several existing risk factors for CLABSI occurrence could explain the limited optimisation of CLABSI reduction in the Greek ICU context, which was struggling to find a balance between limited medical supplies and unacceptably low nursing capacity. Nevertheless, the overall results highlight that 'context matters most' when the behaviours of the individuals who practice in that context are assessed and modified accordingly.

The present study used an uncontrolled, before-and-after research design that aimed to assess the effectiveness of a multifaceted theory-based intervention on CLABSI rates, HCWs' adherence to CLABSI evidence- based preventive practices, and contextual and behavioural beliefs within a Greek medical ICU.

Six research objectives guided the conduct of the thesis. These were to:

- Establish CLABSI rates and HCWs' adherence to evidence-based CLABSI preventive practices in a single site;
- Identify contextual influences on the implementation of CLABSI preventive practices in a single site;
- Identify the behavioural determinants (self-efficacy, intention, attitudes, social influence, and motivation) of HCWs toward CLABSI prevention in multiple sites;
- Develop an intervention based upon baseline behavioural and contextual elements;
- Implement the intervention in a single site;
- Evaluate the effects of the intervention on CLABSI rates, adherence to evidence-based CLABSI preventive practices, knowledge of CLABSI prevention, and contextual and behavioural influences, in the implementation of evidence-based CLABSI preventive practices.

This chapter demonstrates how the above objectives have been met through the present research. A critical discussion on the key findings of the study with regard to the wider literature follows. Contrasting and confirming findings are highlighted and the study's contribution to the field of CLABSI prevention is highlighted. Having regard to the richness of the research findings, only the most striking findings, which have implications for research into infection control, prevention and implementation, are examined. The strengths and limitations of the study are then examined, focusing on the research design and the research approaches used. The study's implications for policy, practice and future research, together with its contribution to knowledge, are also presented in this chapter.

8.2 Effectiveness of the intervention

The findings of the current study emphasise the importance of having a theoretical understanding of the QI (quality improvement) intervention and the contextual barriers and facilitators prior to the development of a QI intervention. In the following sections, findings from the baseline and intervention periods are critically discussed.

8.1.1 Baseline characteristics

The first four objectives of this study were to establish baseline data with regard to CLABSIs and rates of adherence to CLABSI preventive measures. Moreover, behavioural and contextual influences were assessed prior to the implementation of the intervention.

Baseline CLABSI rates were at 10.5/1000 catheter days in the intervention site, highlighting the major problem of high rates of HCAIs existing in Greece. The study's findings regarding adherence to CLABSI preventive practices confirm previous research suggesting that suboptimal CLABSI preventive practices are still used, and that adherence is influenced by a lack of proper training and equipment (Higuera et al. 2005, Lobo et al. 2010, The Joint Commission 2012, Ider et al. 2012). Moreover, the baseline results extend the wider literature, indicating the need to audit all CLABSI practices, and particularly CVC handling, since in cases of high CLABSI rates and excellent adherence to CVC insertion events occurring after insertion might be responsible for the infections (Pronovost et al. 2006, Guerin et al. 2010, Cherifi et al. 2013, Furuya et al. 2016).

Baseline results empirically support the theory that strong attitudes regarding the implementation of evidence-based CLABSI preventive measures influence critical care physicians' and nurses' intention to implement such measures. Moreover, physicians held stronger beliefs about the likelihood that their implementing of these practices would lead to certain consequences, in contrast to previous research which identified that nurses had stronger beliefs about the benefits of intended elective in- hospital hand washing (Whitby et al. 2006). Insignificant results for the other two determinants (self-efficacy and subjective norms) may not indicate that they are unimportant considerations in the formation of HCWs' intention. Positive feedback and reward from medical and nursing directors seemed to be significant motivational factors for HCWs, emphasising the importance of leaders' roles in promoting and sustaining adherence to infection control and prevention measures among HCWs (Pittet et al. 2000, Lankford et al. 2003, Al-Tawfiq & Pittet 2013, Sax et al. 2013). The results of this research contribute to further understanding of the Theory of Reasoned Action and self-efficacy in the context of health behaviour change. Additionally, the current study adds to the wider literature by demonstrating that both behavioural and contextual influences relating to CLABSI prevention need to be assessed prior to development of an intervention, to better understand non-adherence and to design effective infection control and prevention programmes (Pittet et al. 2000, O'Boyle et al. 2001, De Wandel et al. 2010, Krein et al. 2010, Cane et al. 2012).

Physicians' and nurses' baseline knowledge about CLABSI prevention can be explained by the observed absence of written policies, shortage of nurses and lack of in-service training factors, which have been identified as contributing to a decrease in knowledge about CLABSI prevention (Bianco et al. 2013). However, as demonstrated by the wider literature, HCWs' awareness of CLABSI prevention remains inconsistent and limited (Labeau et al. 2009, Chen et al. 2015). The contextual influences affecting CLABSI prevention among physicians and nurses at the baseline showed that nurses were demotivated to implement CLABSI preventive measures by their working conditions. By contrast, physicians have cultivated high performance standards and a strong infection control culture which is conducive to change. However, both groups seemed disempowered to foster a common professional community approach, thus diminishing the opportunity to effectively address the problem of high CLABSI rates at the intervention site (Dixon-Woods et al. 2011).

The following sections discuss the effectiveness of a theory-based, multifaceted intervention relating to CLABSIs and adherence rates, and behavioural and contextual influences, within a Greek medical ICU, in accordance with the sixth objective of the study.

8.1.2 CLABSI rates

The results of the current study are not in line with the vast majority of similar QI interventions, which demonstrated a beneficial influence on CLABSI prevention following the implementation of QI strategies (Blot et al. 2014, Ista et al. 2016). CLABSI rates in the current study remained much higher after the intervention, compared with internationally reported rates (Dudeck et al. 2013, Rosenthal et al. 2014). However, in this study, despite the finding that adherence to CVC handling was improved and excellent performance in CVC insertion and site care was observed, this combination was not reflected in lower CLABSI rates. The reason behind this is unclear, and a cautious interpretation of the results is required. In the following paragraphs, the wider context with regard to high CLABSI rates at the intervention site will be discussed.

High and unchanged CLABSI rates at the intervention ICU can be explained by a high CVC utilisation ratio (<0.90 catheter days / patient days), which is similar to other studies conducted within Greek ICUs (Dima et al. 2007, Apostolopoulou et al. 2013). By contrast, the CVC usage ratio is less in European and US ICU settings, ranging from 0.59 to 0.78 (Dudeck et al. 2013, van der Kooi et al. 2018, respectively), highlighting the severity of illness of the patients at the intervention site (Jarvis et al. 1991). On the other hand, given that CVC necessity was not assessed at the intervention site, it seems that, firstly, the ICU team viewed CVC insertion as a standard procedure on admission to the ICU, and secondly, this decision was not reviewed daily, and hence the necessity for the catheter was not questioned (Laupland et al. 2017). This implies that CVCs could be used more judiciously, since CLABSIs are caused by their presence. The time prior to development of CLABSIs was 13.8 days in the baseline period and 11.6 days during the intervention period, indicating that events occurring after CVC insertion might be responsible for CLABSIs, given the excellent CVC insertion adherence rate at the intervention site (McMullan et al. 2013). In addition, Greece has the highest antibiotic consumption rates in Europe, and thus patients are more prone to develop BSI during their hospitalisation, particularly through multidrug-resistant pathogens, creating obvious challenges for effective antimicrobial treatment (Miyakis et al. 2011). Similarly, high antibiotic consumption in the Republic of Korea might explain why the study by Jeong et al. (2013) did not achieve significant CLABSI reduction following the intervention. In the current research, the microbiology of CLABSIs was in line with previous studies undertaken within Greek

ICUs (Dima et al. 2007, Apostolopoulou et al. 2013) and in European ICUs (van der Kooi et al. 2018). Gram-negative isolates were prevalent with *Acinetobacter baumanii* being endemic in the current study, thus increasing the burden of CLABSI prevention, since the high incidence of this pathogen is caused by ineffective infection control policies (Munoz-Price & Weinstein 2008).

The abovementioned results, combined with the fact that Greece has the highest consumption of antibiotics among European countries (Watson 2012), indicate that critical care patients in Greek ICUs are at high risk of developing CLABSIs and that such infections constitute a major threat for adult patients within Greek ICUs. It is apparent that CLABSI rates in Greece will further escalate unless targeted initiatives are immediately implemented at local and national level (Miyakis et al. 2011, Sotiropoulos et al. 2017).

8.1.3 Adherence to CLABSI preventive practices

Most QI interventions relating to CLABSI prevention have reported CLABSI rates as outcome data, as evidenced in Ista et al. (2016). Lack of process measurement does not allow testing of whether there is a change in clinical behaviour, and furthermore it does not allow the assessment of associations between process and outcome (Pronovost et al. 2010, Hocking & Pirret 2013, van der Kooi et al. 2018). This study is among the few that have measured adherence to all CLABSI preventive practices (CVC insertion, handling and site care) in contrast with the wider literature, as only three studies have reported adherence data in line with this study (Lobo et al. 2010, Hocking et al. 2013, Cherifi et al. 2013. Limited reporting of adherence data supports the view that audit is a resource-intensive process and that not all ICUs can allocate personnel to apply it (Pronovost et al. 2006).

In the present study CVC bundles for all CVC practices (insertion, handling and site care) were applied during the intervention period, in combination with other QI strategies. However, the most non-compliant item (Sacks et al. 2014), namely daily review of CVC necessity, was not targeted, which partly explains the high CVC usage ratio at the intervention site. Unlike previous research which identified that physicians do not adhere to guidelines (Rello et al. 2002), among physicians the adherence to CVC insertion was excellent at the intervention site, both before and after the intervention, as observed in previous studies (Guerin et al. 2010, Cherifi et al. 2013). By contrast, adherence to CVC insertion was suboptimal (<60%) elsewhere (Rosenthal et al. 2010, Seddon et al. 2011, Jeong et al. 2013, Hocking et al. 2013). The current study identified many reasons that could explain why physicians at the intervention site consistently applied evidence-based practice. These reasons are consistent with previous studies which demonstrated that high adherence was facilitated by physicians' prior sensitisation to CLABSI evidence-based measures (Cherifi et al. 2013), their engagement with teaching and research (Jain et al. 2006, Apisarnthanarak et al. 2010), and the use of a CVC trolley (Pronovost et al. 2006, McPeake et al. 2012).

Adherence to CVC post-insertion (CVC handling and site care) practices was improved in the current study. However, adherence to CVC handling practice was suboptimal, and an opportunity for improvement that might reduce CLABSI rates was revealed, given that adherence of ≥95% has been associated with the greatest reduction in CLABSI rates (Furuya et al. 2016). Despite appropriate equipment becoming available through the purchasing of IV medication trays, along with the provision of intensive hands-on training for nurses, adherence to the Aseptic Non-Touch Technique was not optimised. By contrast, while adherence to CVC handling practice improved>80% in similar studies, it did not reach 100% (Guerin et al. 2010, Lobo et al. 2010, Cherifi et al. 2013, Khalid et al. 2013, Hocking et al. 2013). In the present study, even though proper hand hygiene was observed, and clean gloves were worn, nurses did not maintain clean hands prior to accessing the catheter. Previous studies have reported excellent use of gloves before accessing the catheter (Lobo et al. 2010, Khalid et al. 2013); however, use of gloves does not always mean clean hands. More recent studies suggest that ICUs that already achieve high CVC insertion adherence should include CVC post-insertion best practices in order to optimise prevention of CLABSIs (Guerin et al. 2010, Longmate et al. 2011). However, evidence regarding the effectiveness of CVC handling bundles is not strong, due to the limited number of studies which evaluated this practice as part of their intervention. The current study has therefore added to the wider research into CLABSI prevention by evaluating adherence to both CVC post-insertion practices (CVC handling and site care).

Inconsistencies in CVC handling practice during the intervention period can be attributed to an increased nursing workload due to a low nurse-to-patient ratio (1:3), in contrast with previous similar studies in which the nurse-to- patient ratio was 1:1 in the ICU settings during implementation of the intervention (Khalid et al. 2013, Hocking & Pirret 2013). Furthermore, during the current study there was a high rate of turnover of experienced ICU nurses during the intervention period. Thus, the additional workload resulting from the reduced number of nurses during the intervention period may also explain why ICU nurses' adherence to CVC handling did not exceed 66%. These results are consistent with other studies which found that nursing shortages are barriers to implementing CLABSI bundles (Krein et al. 2010) and that increased workload within an ICU was associated with high infection rates and low quality of care (Robert et al. 2000, Hugonet et al. 2007, Aiken et al. 2012). High levels of burn-out and emotional exhaustion, as a result of changes in working conditions during the financial crisis in Greece, have been identified in the Greek literature (Rachiotis et al. 2014, Skefales et al. 2014). The nursing shortage at the intervention site gave rise to 'cutting corners', leading to suboptimal practices, with consequences for CLABSI prevention (Shah et al. 2015). However, high workload does not inevitably lead to decreased patient safety (Endacott 2012).

8.1.4 Contextual and behavioural influences

Knowledge scores regarding CLABSI prevention improved significantly in both administrations during the intervention period, in comparison with the baseline scores. These findings highlight the contribution of hands-on training and targeted education to increasing HCWs' awareness about CLABSI prevention, as reported in similar previous studies (Santana et al. 2008, Perez Parra et al. 2010, Humphrey 2015). After the completion of the education programme and nurses' training, the adherence to CVC post- insertion care improved significantly. Both questions, regarding the frequency of CVC dressing replacement and the frequency of replacement of IV sets when lipid emulsions are administered, were answered correctly by 91.7% of the nursing team. Consistently with other studies (Santana et al. 2008), although physicians used chlorhexidine 2% for skin disinfection before CVC insertion, only 57.1% and 72.1% of physicians (in the first and second administration respectively) knew that this skin disinfectant was more effective compared with 10% povidone-iodine or 70% alcohol in terms of bloodstream infection risk (Mimoz et al. 2015). The current study showed that education and hands-on training of nurses represented leverage on them to increase their awareness of and adherence to CLABSI prevention, although evidence suggests that improved knowledge does not always translate into fewer infections (Kennedy et al. 2004).

Understanding whether or how context explains the effectiveness of a QI intervention in a particular setting could demonstrate how much of the outcomes were attributed to the intervention and to the context, while also assisting in disseminating faster the proven changes in other similar settings (Ovretveit 2011). The nurses' perceptions about the context of the intervention site were stronger at the end of the intervention period compared to the baseline period. In addition, they perceived the ICU's culture, leadership and evaluation of practices as being stronger after the intervention period. These findings emphasise the merits of the study's intervention, given that before the intervention nurses revealed low expectations regarding nurse-physician collaboration, and a negative emotional context. This lends support to findings indicating that where nurses see themselves as assistants, and separation between physicians and nurses exists, the effective use of infection control practices is hindered (Krein et al. 2010, Prohibit 2017). However, a combination of systematic data collection, tailor-made education by a trained nurse, regular feedback, use of visual reminders, positive feedback from the directors and regular feedback of the collected data succeeded in shifting nurses' mindset towards an infection control and prevention culture. These contextual factors seemed to have an important place in the implementation of the study's intervention, being referred to as 'conditions for improvement' and including internal elements such as the unit's culture, structural characteristics and interpersonal relationships (Sax et al. 2013).

The organisational climate, with regard to 'everybody was engaged' (Uchida et al. 2011) in infection control and prevention, evolved during the intervention. The medical team at the intervention site had already cultivated a strong and cohesive culture, in which structures, processes, inter- organisational networking and strong teaching orientation were encouraged and supported, which was similar to the situation in other ICU contexts (Krein et al. 2010, McAlearney et al. 2013). It appeared that the medical director's transformational leadership style encouraged physicians to achieve their fullest potential through teaching and research endeavors. As a result of such supportive leadership, physicians felt trusted and were willing to voice their concerns regarding high CLABSI rates, and to offer suggestions to improve patient care. At the end of the intervention period, leadership was perceived higher among nurses compared to baseline, corresponding to two developments during the intervention period. Firstly, the nursing team started to perceive high CLABSI rates as being a problem, and secondly the ICU nursing manager adopted a more proactive approach regarding CLABSI prevention. Although the nursing team felt demotivated due to their practice environment conditions (the very low number of nurses), it seems that this difficulty also reminded them that violations of standards can also compromise patient safety (Belela-Anacleto & Pedreira 2017). The short duration of the intervention did not provide the opportunity to identify further scope for improvement in the ICU's readiness to apply evidence-based practices and in nurses' adherence to CVC handling practice. It was argued that, when experiencing changes, individuals will go through a period of processing, until they make sense of the change and incorporate it into the social norms of their workplace (Sax et al. 2013). Identification of HCWs' behavioural determinants provides an understanding of their underlying beliefs, to help in developing effective QI interventions and to specify how behavioural change occurs (Abraham & Kelly 2009, Michie et al. 2011). For the first time, critical care physicians and nurses' behavioural determinants regarding implementation of CLABSI evidence-based practices were evaluated using a theoretical model (Ajzen & Fishbein 1975, Bandura 1986). HCWs' behavioural beliefs changed significantly, indicating that persuasive communication about the positive consequences of implementing evidence-based CLABSI preventive measures was effective during the intervention, as found by previous studies (French et al. 2012). The findings of the current research add to the body of implementation science literature, as little is known about how to effectively change HCWs' beliefs (Fishbein & Ajzen 2010).

In summarising this section, the study's intervention, although not affecting CLABSI rates, significantly increased adherence to CVC handling practice while maintaining excellent adherence to CVC insertion and site care practices. Behavioural and contextual elements changed after the intervention, highlighting firstly the importance of establishing a baseline estimate of safety culture and implementation fitness, and secondly that the combination of the intervention's components used at 'the sharp end' of the ICU was effective.

8.3 Strengths and limitations of the study

An increased body of literature concerning CLABSI prevention has confirmed that CLABSIs are largely preventable (Wise et al. 2013, van der Kooi et al. 2018).

However, wide variability of practice still exists and CLABSI preventive practices are sub-optimally implemented (Umscheid et al. 2011). There are no known studies providing a scientific rationale for the selection of the interventions used and which could thus enable the explanation of clinical behaviour in terms of factors that are amenable to change. The present study addressed this gap in the literature by identifying both behavioural and contextual barriers upon which a QI multifaceted intervention was developed, implemented and evaluated.

This is the first study which developed a questionnaire, based on the study's underpinning theoretical model, specifically to identify HCWs' intention, attitude, behavioural beliefs, subjective norms, normative beliefs and self- efficacy (Fishbein & Ajzen 1975, Bandura 1986). The validity of this newly developed questionnaire was not tested for sample sizes greater than those recommended (Francis et al. 2004). However, extensive preliminary work, including an elicitation study and pilot study, was undertaken to develop the questionnaire's statements that operationalised critical care physicians' and nurses' behavioural determinants in the implementation of evidence-based CLABSI preventive measures. Therefore, this study contributes to the wider CLABSI prevention literature, given the growing importance of behavioural interventions in infection control and prevention (Aboelela et al. 2007). However, certain limitations must be acknowledged. One limitation lies in the fact that the sample was not sufficient to perform factor analysis to validate the psychometric properties of the questionnaire (Kline 2013); however, the rigorous process for its development supports the strength of its use in this study.

The majority of QI studies primarily offer CLABSI outcome data (Ista et al. 2016). In this study, data regarding adherence to all CLABSI evidence- based practices were obtained before and after implementation of the intervention, and therefore the strength of this study lies in measuring the full impact of the CLABSI preventive bundles. Some 'Hawthorne effect' might have affected the adherence results, due to the researcher's presence (Gould et al. 2017). However, the researcher spent sufficient time in the field to ensure that the data collected were typical within the research setting.

The use of an experimental design was deemed to be the most appropriate means of assessing the effectiveness of the study's intervention. Randomised controlled trials (RCTs) provide a rigorous method for determining whether an intervention is effective. However, QI interventions are complex in nature and are implemented in real world settings, which make it difficult to eliminate several well-known confounding factors (Auerbach et al. 2009, Mauger et al. 2014). A before-and-after design, without a concurrent control group, was used in the present study. This is a limitation of the study; however, this design was considered to be largely appropriate for the Greek context, given that surveillance of CLABSI rates is not consistently applied within Greek ICU settings. The current study was conducted in one ICU, in a single centre, and therefore its findings cannot be generalised to include all ICU patients in Greece. Such ICUs are small, with only a small number of staff, so designs using RCTs are not feasible for a single unit because there is unlikely to be sufficient power. However, previous studies are consistent with the characteristics of CLABSIs, patients and the ICU as revealed in the study (Dima et al. 2007, Miyakis et al. 2011, Apostolopoulou et al. 2013, Sotiropoulos et al. 2017).

A mixed-methods approach was used, combining quantitative and qualitative methods to better understand the contextual barriers and facilitators in the implementation of evidence-based CLABSI preventive practices. The use of a mixed-methods approach shed light on the contextual concepts and relationships, especially in the context of high variability, and therefore advances empirical knowledge of CLABSI prevention and increases understanding of the implementation process (Creswell et al. 2003, Sax et al. 2013). This study was therefore successful in respect of the intervention's adherence to implementing its content (intervention fidelity) and its effectiveness through being adaptable to a range of situations. The effectiveness of the intervention in respect of contextual and behavioural influences was not assessed with paired-sample t-test statistics. Comparison of the questionnaires was not feasible, as some of the participants were reluctant to record their personal data on the study's questionnaire because the study was conducted within one ICU. Several recommendations and implications are drawn from the findings of this study with regard to theory, research, policy and practice. These are discussed in the following sections.

8.4 Implications for theory

One important contribution of the present study is the development of a new questionnaire which used the Theory of Reasoned Action and self-efficacy (Ajzen & Fishbein 1975, Bandura 1986) to identify what does or does not motivate physicians and nurses to implement best practice regarding CLABSI prevention. In the present research, physicians and nurses had a strongly positive attitude toward CLABSI prevention, which was the only predictor of their intention to adhere to CLABSI preventive measures. However, behavioural and normative beliefs were significantly associated with nurses' intention to implement CLABSI preventive measures. Approval, rewarding and positive feedback by the medical and nursing directors were also reported by physicians and nurses as factors motivating them to adhere to CLABSI preventive measures. Subjective norm was expected to predict nurses' intention to implement CLABSI preventive measures, given the findings from the informal discussions with them, and observation of the context. Building on the current study's findings, further adaptation of subjective norm and normative belief scales, through more in-depth preliminary work with critical care personnel, is suggested as a way to increase the number of items assessed using the above concepts.

CLABSI prevention has evolved remarkably during the past two decades. Strong emphasis has been given to various types of education and the use of bundles and checklists. However, existing suboptimal practice in CLABSI prevention indicates that more needs to be done. This is an appropriate time to gain knowledge from behavioural sciences that could influence CLABSI prevention, since it is people who implement the checklists. During the last eight years the Greek healthcare system has been characterised by low morale, job dissatisfaction and personnel redundancies. This study has shown that, by targeting specific behavioural barriers that were identified using a theory, there is the potential to change behaviour; it has also provided some explanations of why certain strategies were more effective than others.

8.5 Implications for future research

The study was undertaken during a time of financial crisis, ongoing health policy changes and nursing staff reductions, particularly within ICU settings. Compared with European rates, national CLABSI rates within ICUs in Greece were far higher during the study period. Moreover, patients admitted to an ICU have high-risk profile (in terms of developing CLABSIs).

Therefore, innovative methods of surveillance, prevention and treatment are required in order to reduce CLABSIs in such a high-risk cohort of ICU patients. Moreover, neither legally enforceable regulations concerning the implementation of infection control, nor national CLABSI guidelines, exist in Greek ICUs. National adherence data relating to these guidelines is not available, as there are no studies to either confirm or challenge adherence.

The findings of the current study can inform future research in Greece with regard to adherence to CLABSI preventive practices and the need to establish data at national level. Considering the high-risk profile of critical care patients in Greece, further research is needed to identify whether these hardly non-modifiable risk factors account for CLABSIs, or whether the high CLABSI rates are due to HCWs' partial adherence to CLABSI preventive practices. CLABSI national data is also limited, mainly due to a lack of appropriate organisational infrastructures and trained personnel. However, the problem of high infection rates in Greek ICUs cannot be effectively targeted without measuring how high they are and establishing the characteristics of patients, CLABSIs and ICU settings.

The current research indicated that the context can influence behavioural change and how a patient safety intervention works. Further qualitative research could identify whether common contextual barriers exist within Greek ICU settings. By targeting certain aspects of context and behaviour, the intervention phase of the study demonstrated synergies between the selected QI interventions, which influenced HCWs' performance. Further research within Greek ICUs and among critical care personnel could provide stronger evidence of whether the study's particular QI strategies could be effective in improving context and behaviour with regard to CLABSI prevention. The present study also highlighted that Greek nurses were not aware of the principles behind maintenance of the Aseptic Non-Touch Technique prior to accessing a CVC. The findings of the study, alongside the related educational material that was developed, could inform nursing educators within hospitals and nursing teaching institutions in Greece about the practice of this technique.

8.6 Contribution of the study to knowledge

While acknowledging its limitations, several features of this study contribute to our understanding about the conditions under which the implementation of all CLABSI preventive practices is likely to be successful. Although CLABSI rates were not influenced by the intervention, this study progressed towards a better understanding of the determinants of adherence at both the behavioural and contextual levels. Unlike the few previous studies which identified barriers to CLABSI prevention, the current research assessed both behaviour and context, developed an intervention and evaluated its effectiveness in a real-world setting.

Few studies have previously assessed the contextual barriers affecting CLABSI prevention, while no known study has assessed which behavioural determinants motivate or do not motivate HCWs to adhere to CLABSI preventive practices. Observation of the context is crucial in establishing an infection control culture at the baseline and identifying whether an intervention could feasibly be implemented. The current study contributes to implementation science by developing, for the first time, an intervention which draws on both behavioural and contextual influences, thus providing scientific knowledge of how best to address behavioural and structural issues. Given the complexities inherent in QI interventions, and the turbulent Greek context influencing the risk profile of ICU patients, the examination of both numeric outcomes and process measures, along with behaviour, was essential.

The study argues that it is not the checklists that matter, but the people who implement them; therefore, the identification of behavioural determinants of non-adherence is fundamental. The study also draws attention to the importance of persuasive communication, positive feedback and rewards from medical and nursing directors in motivating HCWs to implement evidence-based practice. Furthermore, the current research argues that, in order to sustain improved behaviours, contextual influences must be considered or measured. The study therefore contributes to the field of implementation science by clarifying which actions and activities had the greatest likelihood of consistent success, and hence increases the ability to improve an intervention in respect of outcomes and process indicators.

The multifaceted intervention of this study concerning CLABSI prevention provides empirical evidence of its effectiveness, not only in relation to adherence rates but also regarding behavioural and contextual influences. The study therefore adds clarity regarding both the content of the intervention and the rationale behind the selection of the intervention's components. The study highlights that the combination of a theory from behavioural sciences, together with the assessment of context, prior to implementation of a QI programme, is necessary to understand what influences HCWs to implement evidence-based practices, and which contextual barriers must be targeted. Literature in the field of implementation science has highlighted the importance of context to patient safety, while literature relating to infection control and prevention stresses the human factor in the prevention of infections. This study has shown that context and behaviour can be assessed in parallel, to optimise the effect of a QI intervention.

The study contributes methodologically through the development of a questionnaire. This has been rigorously developed and pilot-tested, and represents the first questionnaire to operationalise self-efficacy, attitude, subjective norms, behavioural and normative beliefs, and intention in the implementation of CLABSI preventive practices among critical care physicians and nurses. Therefore, it is proposed that this questionnaire should be utilised to examine behavioural determinants in a wider critical care population. Furthermore, the research approaches employed in the current study proved beneficial in assessing behavioural and contextual influences through quantitative and qualitative methods, thus providing fidelity regarding identified barriers related to CLABSI prevention.

Overall, it is argued that this study has added to the body of knowledge of understanding in relation to the complexities of implementing QI interventions. Therefore, the value of this study lies in its ability to stimulate further research in the field of infection control and prevention, given the global call for action toward strengthening infection control and prevention in health systems' perspectives.

Lastly, the present study contributes to the field of infection control and prevention in Greece by evaluating, for the first time, whether a comprehensive intervention during a period of financial crisis, ongoing health policy changes and ongoing reductions in nursing staff numbers, particularly in ICU settings, could feasibly be conducted. In times of scarce resources, this study provides evidence that externally facilitated initiatives can be effective in motivating individuals and providing the resources for implementation. This evidence assists policy and decision makers in understanding what resources are required to implement such infection control strategies. This study demonstrated that consistent surveillance of CLABSI data is feasible in a Greek public hospital, as long as infection control and prevention is regarded as a priority by the leadership of medical directors in ICU settings. Greece has been experiencing financial austerity for the last eight years, which implies that the establishment of a surveillance system for HCAIs, along with other infection and control measures, may not currently be a priority for the Greek government. In the era of CLABSI best practice techniques for CVC insertion, handling and site care, CLABSIs still occur in contexts with lower baseline CLABSI rates and better organisational infrastructures. However, this study has shown that, in a context facing economic crisis, consistent CLABSI surveillance, the use of relatively low-cost interventions, which posed no risk for patients, were accepted by the unit's staff and constituted good practice, were feasible.

Responsibility for infection control and prevention is universal and requires the cooperation of both management and front-line staff. This study provides an important opportunity to highlight the fact that Greece's high HCAI problem needs to be identified through sound data at national level, thus requiring mandatory surveillance and reporting of HCAIs. Establishment of reliable data about whether specific risk factors are associated with CLABSI occurrence is crucial for Greek-cohort ICU patients, if prevention and control strategies are to be effective.

The intervention site could serve as a model to make its 'know-how' regarding the surveillance of CLABSIs available to other ICUs in Greece. However, the establishment of the appropriate organisational infrastructure is a national responsibility and all stakeholders should be accountable to adhere to national policies. The study of adherence to CVC handling practices showed that nurses lacked knowledge of the Aseptic Non-Touch Technique, which suggests the need for further training in this practice. This study provides an ideal opportunity for nursing educators within nursing schools and hospitals to include this topic in their infection control and prevention modules. Moreover, the educational material used in the present study could widely facilitate the dissemination of learning to other ICUs in Greece. Collaboration and team support, through conference calls and workshops with other Greek ICUs, would be required to implement the study's intervention in other local settings. *'CLABSI-free Entatiki'* research provided credible answers to quality improvement, and showed that CLABSI prevention in Greece, whilst not easy, is feasible.

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APPENDICES

APPENDIX 1: CLABSI EVIDENCE-BASED PREVENTIVE PRACTICES

CENTRAL VENOUS CATHETER INSERTION PRACTICES (insertion bundle)	System for categorizing recommendations
1. Hand hygiene before and after the procedure	IB
2. Prepare skin with a> 0.5% chlorexidine preparation with alcohol	IA
3. Antiseptic should be allowed to dry prior to placing the catheter	IB
4. Maximal barrier precautions (use of a cap, mask, sterile gloves, and a sterile full body drape)	IA
5. Avoid using the femoral vein in adults patients	IA
6. Daily review of CVC necessity and promptly removal of it	IA
CENTRAL VENOUS CATHETER HANDLING PRACTICES	
1. Hand hygiene before and after the procedure	
2. Maintain aseptic technique for accessing the CVC	IB
3. Minimize contamination risk by scrubbing the access port with an appropriate antiseptic.	IA
4. Accessing port only with sterile devices	IA
CENTRAL VENOUS CATHETER SITE DRESSING	
1. Hand hygiene before and after the procedure	IB
2. Use either sterile gauze, transparent, semi-permeable dressing to cover the CVC site	IA
3. Maintain aseptic technique for the care of CVC	IB
4. Replace catheter site dressing if the dressing becomes damp, loosened, or visibly very soiled	IB
5. Wear either clean or sterile gloves when changing the dressing on intravascular catheters.	IC
6. Do not use topical antibiotic ointment or creams on insertion sites, except for dialysis catheters, because of their potential to promote fungal infections and antimicrobial resistance	IB

APPENDIX 2: EXAMPLE OF DATA BASE SEARCH: Ovid MEDLINE(R)

1946 to November Week 2 2013

#	Searches	Results
1	adult intensive care unit.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept, rare disease supplementary concept, unique identifier]	422
2	exp Intensive Care Units/	56302
3	adult critical care.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept, rare disease supplementary concept, unique identifier]	207
4	exp Critical Care/	43926
5	or/1-4	92723
6	catheter$.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept, rare disease supplementary concept, unique identifier]	226015
7	exp Catheters/	18345
8	central venous.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept, rare disease supplementary concept, unique identifier]	25494
9	exp Catheterization, Central Venous/	11876
10	or/6-9	234235
11	(improv$ adj2 quality).mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept, rare disease supplementary concept, unique identifier]	63223
12	(preven$ adj2 infection).mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept, rare disease supplementary concept, unique identifier]	10784
13	11 or 12	73910
14	nosocomial infection.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept, rare disease supplementary concept, unique identifier]	4137
15	exp Cross Infection/	47496
16	bacteriemia.mp. [mp=title, abstract, original title, name of substance word, subject heading word, keyword heading word, protocol supplementary concept, rare disease supplementary concept, unique identifier]	696
17	exp Bacteremia/	21928
18	or/14-17	68223
19	5 and 10 and 13 and 18	132
20	limit 19 to (english language and yr="2000 - 2013")	110

APPENDIX 3: OPERATIONAL DEFINITION, ITEM DEFINITION, EXAMPLE ITEM AND MEASURES WITHIN THE THEORY OF REASONED ACTION QUESTIONNAIRE

	Variable	Operational definition	Example item	Measure
	Behavioural intention	Perceived likelihood of performing the behavior	How often do you wash or disinfect your hands before handling of a CVC?	Bipolar never to every time; scored -7 to +7
DIRECT MEASURES OF ATTITUDE AND SUBJECTIVE NORMS	**Attitude**	Evaluation of respondents' general attitude towards implementation of CLABSI evidence-based measures	Overall, I think that implementing EB measures during insertion or care of a central line in order to prevent CLABSI is…	Semantic differential scale: for example, good-bad; scored -7 to +7
	Subjective norm	Subjective judgement regarding the perceived social pressure to adhere with evidence-based CLABSI preventive measures	Colleagues whose opinion I value think that I should NOT implement EB measures during insertion or care of a central line	Bipolar strongly disagree to strongly agree; scored -7 to +7
INDIRECT MEASURES OF ATTITUDE	**Behavioral belief**	Perceived likelihood that implementing evidence-based CLABSI preventive measures will lead to certain advantages and disadvantages	Lack of appropriate number of nurses will restrain me to implement EB measures towards CLABSI prevention	Bipolar strongly disagree to strongly agree; scored -7 to +7
	Outcome evaluation	Evaluation of each of the advantages and disadvantages	Implementing EB CLABSI preventive measures will reduce patients' length of stay in ICU	Bipolar strongly disagree to strongly agree; scored -7 to +7
INDIRECT MEASURES OF SUBJECTIVE NORMS	**Normative beliefs**	Perceived likelihood that important referents would approve/disapprove of HCWs to implement evidence-based CLABSI preventive measures	My medical/nurse director would approve of my Implementing EB CLABSI preventive measures during insertion or care of a central line catheter	Bipolar strongly disagree to strongly agree; scored -7 to +7
	Motivation to comply	HCWs willingness to adhere with the important referents	Generally speaking, I care what my nurse/physician colleagues think that I should do	Bipolar strongly disagree to strongly agree; scored -7 to +7

APPENDIX 4: SCORING KEY FOR THE THEORY OF REASONED ACTION QUESTIONNAIRE

<table>
<tr><th>Construct measured</th><th>Question numbers</th><th>Scoring format</th><th>Items requiring reverse scoring</th><th>Items requiring multiplication</th></tr>
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APPENDIX 5: STUDY'S QUESTIONNAIRE IN ENGLISH LANGUAGE

Particpant's

Code no:................................

Florence Nightingale School of Nursing and Midwifery

KING'S College LONDON

University of London

QUESTIONNAIRE

A quality improvement initiative aiming at reducing Central Line Associated Bloodstream Infections (CLABSIs) in a medical intensive care unit: a pilot study

This questionnaire forms part of a Doctorate thesis. You have been given this questionnaire because you work in an intensive care unit. *The aim of this survey questionnaire* is to identify current practices on central line insertion and care in your unit, to identify any possible barriers that inhibit your compliance with CLABSIs preventive measures and to identify also your views about your working environment.

There are no rights or wrong answers and I am only interested in your opinions. Please, state whether you have any difficulty answering the questions and whether there are items that are ambiguous to you.

I would like to ask you to independently complete the questionnaire as well as to answer all questions. In case you do not find the exact answer that fits your case, mark the one that comes closest to it.

All the information that you give will remain **confidential**. If after completing the questionnaire, you want to add some more information then please use the space at the end of the questionnaire. Please return this questionnaire *in the box* provided to your unit.

PART A: KNOWLEDGE ABOUT CLABSIs PREVENTION

The following statements are referred to guidelines for the prevention of central line (CL) associated bloodstream infections. Questions must be answered from both physicians and nurses. Only one answer is correct. Please, answer each question even if you are not sure about the right answer. Please, circle the letter that best describes your opinion.

1. <u>It is recommended to disinfect the catheter insertion site with . . .</u>

A 2% aqueous chlorhexidine

B 0.5% alcoholic chlorhexidine

C 10% povidone-iodine

D I do not know

2. <u>It is recommended to apply an antibiotic ointment at the insertion site of a CL...</u>

A Yes, because it decreases the risk for catheter-related infections

B No, because it causes antibiotic resistance

C No, because it does not decrease the risk for catheter-related infections

D I do not know

3. <u>When lipid emulsions are administered through a CL it is recommended to replace the administration set . . .</u>

A Within 24 hrs

B Every 72 hrs

C Every 96 hrs

D I do not know

4. <u>When neither lipid emulsions, nor blood products are administered through a CL it is recommended to replace the administration set . . .</u>

A Every 24 hrs

B Every 48 hrs

C Every 96 hrs

D I do not know

5. <u>It is recommended to replace CLs routinely . . .</u>

A Yes, every seven days

B Yes, every three weeks

C No, only when indicated

D I do not know

6. <u>It is recommended to replace CLs over a guidewire . . .</u>

A Yes, every three days

B Yes, every seven days

C No, only when indicated

D I do not know

7. <u>It is recommended to replace pressure transducers and tubing routinely ...</u>

A Yes, every four days

B Yes, every eight days

C No, only when indicated

D I do not know

8. <u>In settings with a high rate of catheter-associated infections it is recommended to use a CL coated or impregnated with an antiseptic agent.</u>

A Yes, in patients whose CVC is expected to remain in place for more than

five days.

B No, because the use of such catheters is not cost-effective

C No, because the use of such catheters does not result in a significant decrease in the rate of catheter-related infections

D I do not know

9. <u>It is recommended to change the dressing on the catheter insertion site</u>

A On a daily basis

B Every three days

C When indicated (soiled, loosened etc) and every 2 days for gauze dressings and at least weekly for transparent dressings

D I do not know

10. <u>It is recommended to cover up the catheter insertion site with . . .</u>

A Polyurethane dressing (transparent, semi-permeable)

B Gauze dressing

C Both are recommended because the type of dressing does not affect the risk for catheter-related infections
D I do not

PART B: SELF-EFFICACY SCALE

A number **of barriers** are described below that can make it hard to implement evidence-based infection control measures when you insert of a central line. Please rate how certain you are that you could overcome the following barriers every time you insert or care a central line.

1. I can manage to perform all infection control measures every time I *insert* a central line, even if nursing staffing is low.

Strongly disagree	**1**	**2**	**3**	**4**	**5**	**6**	**7**	Strongly agree

2. I can manage to perform all infection control measures every time I *insert* a central line, even if there is lack of supplies in the ICU, I work eg drapes, antiseptic, dressing materials

Strongly disagree	**1**	**2**	**3**	**4**	**5**	**6**	**7**	Strongly agree

3. I can manage to perform all infection control measures every time I *insert* a central line in the ICU I work, even if I don't have sufficient time

Strongly disagree	**1**	**2**	**3**	**4**	**5**	**6**	**7**	Strongly agree

4. I can manage to perform all infection control measures every time I *insert* a central line in the ICU I work, even if the insertion of a central line is an emergency procedure

Strongly disagree	**1**	**2**	**3**	**4**	**5**	**6**	**7**	Strongly agree

5. I can manage to perform all infection control measures every time I *insert* a central line in the ICU I work, even if some colleagues may not know about evidence-based guidelines on CLABSIs prevention

Strongly disagree	**1**	**2**	**3**	**4**	**5**	**6**	**7**	Strongly agree

6. I can manage to perform all infection control measures every time I *insert* a central line in the ICU I work, even if occasionally standards of care regarding CLABSIs prevention are low

Strongly disagree	**1**	**2**	**3**	**4**	**5**	**6**	**7**	Strongly agree

7. I can manage to perform all infection control measures every time I *insert* a central line in the ICU I work, even if sometimes there is low reinforcement from hospital administrators to apply evidence-based measures on CLABSI prevention

Strongly disagree	1	2	3	4	5	6	7	Strongly agree

8. I can manage to perform all infection control measures every time I *insert* a central line in the ICU I work, even if in service education regarding CLABSIs prevention is not freely available.

Strongly disagree	1	2	3	4	5	6	7	Strongly agree

9. I can manage to perform all infection control measures every time I *insert* a central line in the ICU I work, even if support from senior medical managers to apply guidelines on CLABSIs prevention is not strong.

Strongly disagree	1	2	3	4	5	6	7	Strongly agree

10. I can manage to perform all infection control measures every time I *insert* a central line in the ICU I work, even if dissemination of infection control policies is not effective.

Strongly disagree	1	2	3	4	5	6	7	Strongly agree

11. I can manage to perform all infection control measures every time I *insert* a central line in the ICU I work, even if some staff disagree with the evidence-based guidelines on CLABSI prevention.

Strongly disagree	1	2	3	4	5	6	7	Strongly agree

PART C: BEHAVIOURAL INTENTION (PHYSICIANS)

The following statements describe **how often you implement** each of the evidence-based preventive measures when you *insert* a central line. Please, circle the answer that it best describes your practice.

1. How often do you **wash or disinfect your hands** before insertion?

1	**2**	**3**	**4**	**5**	**6**	**7**
never			half times			every-time

2. How often do you use **mask** during insertion of a central line?

1	**2**	**3**	**4**	**5**	**6**	**7**
never			half times			every-time

3. How often do you wear **cap** during insertion of a central line?

1	**2**	**3**	**4**	**5**	**6**	**7**
never			half times			every-time

4. How often do you wear **gown** during insertion of a central line?

1	**2**	**3**	**4**	**5**	**6**	**7**
never			half times			every-time

5. How often do you wear **sterile gloves** during insertion of a central line?

1	**2**	**3**	**4**	**5**	**6**	**7**
never			half times			every-time

6. How often do you use sterile **full body drape** during insertion of a central line?

1	**2**	**3**	**4**	**5**	**6**	**7**
never			half times			every-time

7. How often do you use **chlorexidine with alcohol >0.5%,** for skin antisepsis during insertion of a central line?

1	2	3	4	5	6	7
never			half times			every-time

8. How often do you avoid selecting **femoral site** to insert a central line?

1	2	3	4	5	6	7
never			half times			every-time

9. How often do you select **subclavian site** to insert a central line?

1	2	3	4	5	6	7
never			half times			every-time

10. How often do you cover the insertion site with **sterile transparent, semi-permeable dressings**?

1	2	3	4	5	6	7
never			half times			every-time

PART C - BEHAVIOURAL INTENTION (NURSES)

The following statements describe **how often you implement** each of the evidence-based preventive measures when you *care* a central line. Please, circle the answer that it best describes your practice.

1. How often do you **wash or disinfect your hands** before handling a central line?

1	2	3	4	5	6	7
never			half times			every-time

2. How often do you **scrub the access port** or **hub** immediately prior to each use with an appropriate antiseptic (e.g., Chlorhexidine, povidone iodine, an iodophor, or 70% alcohol)?

1	2	3	4	5	6	7
never			half times			every-time

3. How often do you **access catheters** only with sterile devices?

1	2	3	4	5	6	7
never			half times			every-time

4. How often do you **replace dressings** that are wet, soiled, or dislodged?

1	2	3	4	5	6	7
never			half times			every-time

5. How do you **perform dressing changes** under aseptic technique using clean or sterile gloves?

1	2	3	4	5	6	7
never			half times			every-time

PART D - The following statements assess **your opinions/perceptions** toward implementation of evidence-based measures during insertion or care of a central line, to prevent CLABSIs. Please answer each of the following questions by circling the number that best describes your opinion. Some of the questions may appear to be similar, but they do address somewhat different issues. Please read each question carefully.

1-4. Overall, I think that implementing evidence-based measures during insertion or care of a central line in order to prevent CLABSIs is:

Easy practice	1 2 3 4 5 6 7	Difficult practice
Important practice	1 2 3 4 5 6 7	Not important practice
Unnecessary	1 2 3 4 5 6 7	Necessary
Good practice	1 2 3 4 5 6 7	Bad practice

5. Implementing evidence-based infection control measures during insertion/care of a central line will reduce expenses.

Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree

6. Implementing evidence-based infection control measures during insertion/care of a central line will reduce CLABSI rates.

Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree

7. Implementing evidence-based infection control measures during insertion/care of a central line, will avoid colonization of the catheter.

Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree

8. Implementing evidence-based measures towards CLABSIs prevention will promote standardization of catheter's insertion or care practice

Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree

9. Implementing evidence-based measures towards CLABSIs prevention will reduce patient's LOS in ICU.

Strongly Disagree 1 2 3 4 5 6 7 Strongly Agree

10. Implementing evidence-based measures towards

Strongly Disagree 1 2 3 4 5 6 7 Strongly Agree

11. Colleagues whose opinion I value think that I should NOT implement evidence-based infection control measures during insertion/care of a central line.

Strongly Disagree 1 2 3 4 5 6 7 Strongly Agree

12. Implementing evidence-based measures towards CLABSIs prevention, it is time consuming.

Strongly Disagree 1 2 3 4 5 6 7 Strongly Agree

13. Lack of appropriate number of nurses will restrain me to implement evidence-based measures towards CLABSIs prevention.

Strongly Disagree 1 2 3 4 5 6 7 Strongly Agree

14. Standardization of practice as a result of implementing evidence-based infection control measures during insertion/care of a central line is desirable.

Strongly Disagree 1 2 3 4 5 6 7 Strongly Agree

15. My medical/nurse director would approve of my implementing evidence-based infection control measures during insertion/care of a central line.

Strongly Disagree 1 2 3 4 5 6 7 Strongly Agree

16. Avoidance of colonization of a central line as a result of implementing evidence-based infection control measures during insertion/care of a central line is desirable.

Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree

17. Colleagues whose opinions I value would approve of my implementing the evidence-based infection control measures during insertion/care of a central line

Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree

18. Increase in time required as a result of implementing evidence-based infection control measures during insertion/care of a central line is not- desirable

Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree

19. Reducing CLABSIs rates as a result of implementing evidence-based infection control measures during insertion/care of a central line is desirable.

Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree

20. It is expected of me that I implement evidence-based infection control measures during insertion/care of a central line

Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree

21. Reducing patients’ length of stay in ICU as a result of implementing evidence-based infection control measures during insertion/care of a central line is desirable.

Strongly Disagree	1	2	3	4	5	6	7	Strongly Agree

22. My nurse/physician colleagues think that I should not implement evidence-based infection control measures during insertion/care of a central line

Strongly Disagree 1 2 3 4 5 6 7 Strongly Agree

23. Reducing expenses as a result of implementing evidence-based infection control measures during insertion/care of a central line is desirable.

Strongly Disagree 1 2 3 4 5 6 7 Strongly Agree

24. For me, not being able to implement the evidence-based infection control measures during insertion/care of a central line as a result of nursing shortage is not desirable.

Strongly Disagree 1 2 3 4 5 6 7 Strongly Agree

25. Generally speaking, I care what my nurse/physician colleagues think that I should do.

Strongly Disagree 1 2 3 4 5 6 7 Strongly Agree

26. The approval of my medical/nurse director is important to me

Strongly Disagree 1 2 3 4 5 6 7 Strongly Agree

27. Reducing wastage of supplies as a result of implementing evidence-based infection control measures during insertion/care of a central line is desirable.

Strongly Disagree 1 2 3 4 5 6 7 Strongly Agree

28. Other physicians/nurses who work in a critical care setting implement evidence-based infection control measures when they insert/handling/care of a central line.

Strongly Disagree 1 2 3 4 5 6 7 Strongly Agree

PART E: CONTEXT ASSESSMENT INDEX

In this section, I am interested in ***your views about your working environment and its readiness to implement evidence-based practice*** (please, respond even if you have not encountered similar situation)**.** For each of the following statements please tick √ in one box only.

How likely would your unit be to provide evidence-based practice	**Strongly agree**	**Agree**	**Disagree**	**Strongly Disagree**
01 Personal and professional boundaries between HCPs[a] are maintained				
02 Decisions on care and management are clearly documented by all staff				
03 A proactive approach to care is taken				
04 All aspects of care/treatment are based on evidence of best practice				
05 The nurse leader acts as a role model of good practice				
06 HCPs provide opportunities for patients to participate in decisions about their own care				
07 Education of staff is a priority				
08 There are good working relations between clinical and non-clinical staff				
09 Staff receive feedback on the outcomes of complaints				
10 HCPs in the MDT have equal authority (respect of expertise work) in decision making				
11 Audit and/or research findings are used to develop practice				

12	A staff performance review process is in place that enables reflection on practice and goal setting and is regularly reviewed				
13	Staff have explicit understanding of their own attitudes and beliefs toward the provision of care				
14	Patients are encouraged to be active participants in their own care				
15	There is high regard for patient's privacy and dignity				
16	HCPs and health care support workers understand each other's role				
17	The management structure is democratic and inclusive				
18	Appropriate information (large written print, tapes, etc.) is accessible to patients				
19	HCPs and patients work as partners, providing individual patient care				
20	Care is based on a comprehensive assessment				
21	Challenges to practice are supported and encouraged by nurse leaders and nurse managers				
22	Discussions are planned between HCPs and patients				
23	The development of staff expertise is viewed as a priority by nurse leaders				
24	Staff use reflective processes (e.g., action learning, clinical supervision, or reflective diaries) to evaluate and develop practice				

25	Organizational management has high regard for staff autonomy (working independently)				
26	Staff welcome and accept cultural diversity				
27	Evidence-based knowledge on care is available to staff				
28	Patients have choice in assessing, planning, and evaluating their care and treatment				
29	HCPs have the opportunity to consult with specialists				
30	HCPs feel empowered to develop practice				
31	Clinical nurse leaders create an environment conducive to the development and sharing of ideas				
32	Guidelines and protocols based on evidence of best practice (patient experience, clinical experience, and research) are available				
33	Patients are encouraged to participate in feedback on quality of care, culture, and systems				
34	Resources are available to provide evidence-based care				
35	The organization is non-hierarchical- (consensus)				
36	HCPs share common goals and objectives about patient care				
37	Structured programs of education are available to all HCPs				

[a]Health care practitioners; [b]Multidisciplinary team

PART F: DEMOGRAPHICS (PHYSICIANS)

In the following section I would like to know some information about you and your workplace. Please tick the appropriate box

Age ________ Female ▫ Male ▫

How long have you worked in the ICU of this hospital?_________years

How long have you worked in critical care area in general?______years

What is your level of appointment?

Consultant ▫

Resident ▫

Fellow ▫

Do you have any additional professional qualifications?

Medical Specilization ▫

Other courses ▫

Please give details___________________________

What is your highest educational qualification?

▫ BSc in Medicine ▫ Masters ▫ Phd ▫

PART F: DEMOGRAPHICS (NURSES)

In the following section I would like to know some information about you and your workplace. Please tick the appropriate box

Age________years Female ▫ Male ▫

How long have you worked in the ICU of this hospital?________years

How long have you worked in critical care area in general?__________years

What is your level of appointment?

Nurse Manager ·

Deputy Nurse Manager ·

Staff nurse ·

Do you have any additional professional qualifications?

Nursing Specilization ·

Other courses ·

Please give details___________________________

What is your highest educational qualification?

· BSc in Nursing · Masters · Phd ·

If you would like to add any further information, please use the space below:

Thank you very much for taking time to complete this questionnaire. If you have any queries regarding this questionnaire, please contact the researcher, Katerina Iliopoulou: 2107494516 katerina.iliopoulou@kcl.ac.uk

Appendix 6: STUDY’S QUESTIONNAIRE IN GREEK LANGUAGE

Αριθμός: ……..
Florence Nightingale School of Nursing and Midwifery
CREC-PNM/13/14/14-78

KING'S College LONDON
University of London

ΕΡΩΤΗΜΑΤΟΛΟΓΙΟ

"Πρωτοβουλία βελτίωσης ποιότητας η οποία στοχεύει στη μείωση των λοιμώξεων αιματικής ροής σχετιζόμενων με παρουσία κεντρικού φλεβικού καθετήρα" (πρωτότυπος τίτλος: *Quality improvement initiative aiming at reducing Central Line Associated Bloodstream Infections-**CLABSIs***)

Αυτό το ερωτηματολόγιο αποτελεί μέρος διδακτορικής διατριβής και σας έχει δοθεί γιατί εργάζεστε σε Μονάδα Εντατικής Θεραπείας (ΜΕΘ). Ο στόχος αυτού του ερωτηματολογίου είναι να αναγνωριστούν οι τρέχουσες πρακτικές σε σχέση με τα μέτρα πρόληψης που πρέπει να τηρούνται κατά την φροντίδα (αλλαγή επιθέματος) και χειρισμό (χορήγηση φαρμάκων, διαλυμάτων) των κεντρικών καθετήρων, να αναγνωριστούν πιθανά εμπόδια τα οποία αναστέλλουν τη συμμόρφωση σας με τα μέτρα αυτά και να διερευνηθούν οι απόψεις σας για το εργασιακό σας περιβάλλον.

Θα ήθελα να σας παρακαλέσω να συμπληρώσετε το ερωτηματολόγιο ο καθένας μόνος του καθώς και να απαντήσετε σε όλες τις ερωτήσεις. Δεν υπάρχουν σωστές και λανθασμένες απαντήσεις, ενδιαφέρομαι μόνο για τις απόψεις σας.. Σε περίπτωση που καμία προτεινόμενη απάντηση δεν σας αντιπροσωπεύει απόλυτα, επιλέξτε εκείνην που ταιριάζει περισσότερο στη δική σας περίπτωση.

Όλες οι πληροφορίες που θα δώσετε θα παραμείνουν **αυστηρά εμπιστευτικές**. Εάν μετά από τη συμπλήρωση του ερωτηματολογίου επιθυμείτε να προσθέσετε επιπλέον πληροφορίες, μπορείτε να χρησιμοποιήσετε το χώρο στο τέλος του ερωτηματολογίου.

Ενότητα Α
Οι παρακάτω πολλαπλής επιλογής ερωτήσεις αναφέρονται στις προτεινόμενες κατευθυντήριες οδηγίες για την πρόληψη των λοιμώξεων που σχετίζονται με τους κεντρικούς καθετήρες (*Central Line Associated Bloodstream Infections*-**CLABSIs**). Για κάθε ερώτηση υπάρχουν 4 πιθανές απαντήσεις από τις οποίες **μόνο μια** είναι η σωστή. Παρακαλώ, κυκλώστε την απάντηση που πιστεύετε ότι είναι σωστή.

1. Συνιστάται η αντισηψία του σημείου εισόδου του φλεβικού κεντρικού καθετήρα με….

Α 2% υδατική χλωρεξιδίνη
Β 0,5% αλκοολική χλωρεξιδίνη
Γ 10% ιωδιούχο ποβιδόνη
Δ Δεν γνωρίζω

2. Συνιστάται η εφαρμογή αντιβιοτικής αλοιφής στη θέση εισόδου ενός κεντρικού φλεβικού καθετήρα …..

Α Ναι, επειδή μειώνει των κίνδυνο λοιμώξεων που σχετίζονται με τη χρήση καθετήρα
Β Όχι, επειδή δημιουργεί αντίσταση στα αντιβιοτικά
Γ Όχι, επειδή δεν μειώνει τον κίνδυνο λοιμώξεων - **CLABSIs** που σχετίζονται με τη χρήση καθετήρα
Δ Δεν γνωρίζω

3. Όταν χορηγείται μέσω κεντρικού φλεβικού καθετήρα εναιώρημα λιπιδίων, συνιστάται η αντικατάσταση της συσκευής χορήγησης….

Α Εντός 24 ωρών
Β Κάθε 72 ώρες
Γ Κάθε 96 ώρες
Δ Δεν γνωρίζω

4. Όταν δεν χορηγούνται, μέσω κεντρικού φλεβικού καθετήρα, εναιωρήματα λιπιδίων ή προϊόντα αίματος, τότε συνιστάται η αντικατάσταση της συσκευής χορήγησης ….

Α Κάθε 24 ώρες
Β Κάθε 48 ώρες
Γ Κάθε 96 ώρες (4 ημέρες)
Δ Δεν γνωρίζω

5. Συνιστάται η αντικατάσταση των κεντρικών φλεβικών καθετήρων..

Α Ναι, κάθε 7 ημέρες
Β Ναι, κάθε 3 εβδομάδες
Γ Όχι, μόνο όταν ενδείκνυται
Δ Δεν γνωρίζω

6. Συνιστάται η αντικατάσταση των κεντρικών φλεβικών καθετήρων πάνω σε σύρμα-οδηγό…

Α Ναι, κάθε 3 ημέρες

Β Ναι, κάθε 7 ημέρες

Γ Όχι, μόνο όταν ενδείκνυται

Δ Δεν γνωρίζω

7. Συνιστάται η αντικατάσταση των μορφο-μετατροπέων πίεσης (transducers) και των συσκευών χορήγησης διαλυμάτων

Α Ναι, κάθε 4 ημέρες

Β Ναι, κάθε 8 ημέρες

Γ Όχι, μόνο όταν ενδείκνυται

Δ Δεν γνωρίζω

8. Όταν υπάρχει υψηλός δείκτης λοιμώξεων που σχετίζονται με τους κεντρικούς φλεβικούς καθετήρες **(CLABSIs)**, συνιστάται η χρήση καθετήρα επικαλυπτόμενου ή εμβαπτισμένου με αντισηπτικό παράγοντα…

Α Ναι, σε ασθενείς με κεντρικό καθετήρα που αναμένεται να παραμένει περισσότερο από πέντε ημέρες

Β Όχι, γιατί το κόστος τέτοιων καθετήρων είναι υψηλό σε σχέση με την αποδοτικότητά τους

Γ Όχι, γιατί η χρήση τέτοιων καθετήρων δεν οδηγεί σε σημαντική μείωση των δεικτών των λοιμώξεων που σχετίζονται με τους κεντρικούς καθετήρων **(CLABSIs)**

Δ Δεν γνωρίζω

9. Συνιστάται η αλλαγή του επιθέματος στο σημείο εισόδου του καθετήρα….

Α Σε ημερήσια βάση

Β Κάθε 3 ημέρες

Γ Όταν ενδείκνυται (υγρασία, χαλαρά τα όρια του επιθέματος, λερωμένο επίθεμα) και τουλάχιστον μία φορά την εβδομάδα

Δ Δεν γνωρίζω

10. Συνιστάται η κάλυψη του σημείου εισόδου του καθετήρα με...

Α Επίθεμα πολυουρεθάνης (διαφανές, ημιδιαπερατό)

Β Επίθεμα γάζας

Γ Και τα δύο προτείνονται αφού ο τύπος του επιθέματος δεν επηρεάζει τον κίνδυνο εμφάνισης λοιμώξεων που σχετίζονται με κεντρικούς καθετήρες **(CLABSIs)**

Δ Δεν γνωρίζω

Ενότητα Β

Παρακάτω περιγράφεται ένας αριθμός **εμποδίων** τα οποία δυσκολεύουν την εφαρμογή των προληπτικών μέτρων των λοιμώξεων που σχετίζονται με την παρουσία κεντρικού φλεβικού καθετήρα (*Central Line Associated Bloodstream Infections*-**CLABSIs)** όταν **αλλάζετε** το επίθεμα ενός κεντρικού καθετήρα ή όταν **χειρίζεστε** αυτόν για να χορηγήσετε φάρμακα, διαλύματα κα. Παρακαλώ, αφού διαβάστε προσεκτικά την κάθε δήλωση κυκλώστε τον αριθμό που εκφράζει καλύτερα τη δυνατότητα που έχετε να εφαρμόζετε τα μέτρα πρόληψης ακόμη και όταν υπάρχουν τα παρακάτω εμπόδια. Δεν υπάρχουν σωστές ή λάθος απαντήσεις. Βεβαιωθείτε ότι απαντήσατε όλες τις ερωτήσεις και μη κυκλώσετε περισσότερες από μια απαντήσεις για την κάθε δήλωση.

Παράδειγμα

Διαφωνώ απόλυτα	**1**	**2**	**3**	**4**	**5**	**6**	**7**	Συμφωνώ απόλυτα

1. Μπορώ να εφαρμόζω όλα τα μέτρα πρόληψης των λοιμώξεων-**CLABSIs** κάθε φορά που χειρίζομαι ή περιποιούμαι έναν κεντρικό φλεβικό καθετήρα, ακόμα και όταν το **νοσηλευτικό προσωπικό** δεν επαρκεί.

Διαφωνώ απόλυτα	**1**	**2**	**3**	**4**	**5**	**6**	**7**	Συμφωνώ απόλυτα

2. Μπορώ να εφαρμόζω όλα τα μέτρα πρόληψης των λοιμώξεων-**CLABSIs** κάθε φορά που χειρίζομαι ή περιποιούμαι έναν κεντρικό φλεβικό καθετήρα, ακόμα και όταν υπάρχει **έλλειψη υλικών** όπως επιθέματα, αποστειρωμένα πεδία, αντισηπτικά κά. Διαφωνώ απόλυτα **1** **2** **3** **4** **5** **6** **7** Συμφωνώ απόλυτα
3. Μπορώ να εφαρμόζω όλα τα μέτρα πρόληψης των λοιμώξεων-**CLABSIs** κάθε φορά που χειρίζομαι ή περιποιούμαι έναν κεντρικό φλεβικό καθετήρα, ακόμα και όταν **δεν έχω χρόνο**. Διαφωνώ απόλυτα **1** **2** **3** **4** **5** **6** **7** Συμφωνώ απόλυτα
4. Μπορώ να εφαρμόζω όλα τα μέτρα πρόληψης των λοιμώξεων-**CLABSIs** κάθε φορά που χειρίζομαι ή περιποιούμαι έναν κεντρικό φλεβικό καθετήρα, ακόμα και όταν η τοποθέτηση ενός κεντρικού καθετήρα αφορά **επείγουσα διαδικασία**. Διαφωνώ απόλυτα **1** **2** **3** **4** **5** **6** **7** Συμφωνώ απόλυτα
5. Μπορώ να εφαρμόζω όλα τα μέτρα πρόληψης των λοιμώξεων-**CLABSIs** κάθε φορά που χειρίζομαι ή περιποιούμαι έναν κεντρικό φλεβικό καθετήρα, ακόμα και όταν μερικοί συνάδελφοι μου **δεν γνωρίζουν** τα μέτρα αυτά. Διαφωνώ απόλυτα **1** **2** **3** **4** **5** **6** **7** Συμφωνώ απόλυτα
6. Μπορώ να εφαρμόζω όλα τα μέτρα πρόληψης των λοιμώξεων-**CLABSIs** κάθε φορά που χειρίζομαι ή περιποιούμαι έναν κεντρικό φλεβικό καθετήρα, ακόμα και όταν το **πρότυπα φροντίδας** που σχετίζονται με την πρόληψη των λοιμώξεων είναι **ανεπαρκή**. Διαφωνώ απόλυτα **1** **2** **3** **4** **5** **6** **7** Συμφωνώ απόλυτα
7. Μπορώ να εφαρμόζω όλα τα μέτρα πρόληψης των λοιμώξεων-**CLABSIs** κάθε φορά που χειρίζομαι ή περιποιούμαι έναν κεντρικό φλεβικό καθετήρα, ακόμα και όταν δεν υπάρχει ανάλογη **ενίσχυση** από τη διοίκηση του Νοσοκομείου για την εφαρμογή των μέτρων αυτών. Διαφωνώ απόλυτα **1** **2** **3** **4** **5** **6** **7** Συμφωνώ απόλυτα

8. Μπορώ να εφαρμόζω όλα τα μέτρα πρόληψης των λοιμώξεων-**CLABSIs** κάθε φορά που χειρίζομαι ή περιποιούμαι έναν κεντρικό φλεβικό καθετήρα, ακόμα και όταν η **εσωτερική εκπαίδευση** στη ΜΕΘ δεν επαρκεί.

Διαφωνώ απόλυτα	**1**	**2**	**3**	**4**	**5**	**6**	**7**	Συμφωνώ απόλυτα

9. Μπορώ να εφαρμόζω όλα τα μέτρα πρόληψης των λοιμώξεων-**CLABSIs** κάθε φορά που χειρίζομαι ή περιποιούμαι έναν κεντρικό φλεβικό καθετήρα, ακόμα και όταν οι **προϊστάμενοι/ες δεν υποστηρίζουν** την εφαρμογή των μέτρων αυτών.

Διαφωνώ απόλυτα	**1**	**2**	**3**	**4**	**5**	**6**	**7**	Συμφωνώ απόλυτα

10. Μπορώ να εφαρμόζω όλα τα μέτρα πρόληψης των λοιμώξεων-**CLABSIs** κάθε φορά που χειρίζομαι ή περιποιούμαι έναν κεντρικό φλεβικό καθετήρα, ακόμα και όταν η **ενημέρωση για τα μέτρα ελέγχου** των λοιμώξεων δεν είναι επαρκή.

Διαφωνώ απόλυτα	**1**	**2**	**3**	**4**	**5**	**6**	**7**	Συμφωνώ απόλυτα

11. Μπορώ να εφαρμόζω όλα τα μέτρα πρόληψης των λοιμώξεων-**CLABSIs** κάθε φορά που χειρίζομαι ή περιποιούμαι έναν κεντρικό φλεβικό καθετήρα, ακόμα και όταν κάποιοι από το **προσωπικό δεν συμφωνούν** με τα μέτρα αυτά.

Διαφωνώ απόλυτα	**1**	**2**	**3**	**4**	**5**	**6**	**7**	Συμφωνώ απόλυτα

Ενότητα Γ

Οι παρακάτω δηλώσεις περιγράφουν **πόσο συχνά** εφαρμόζετε το κάθε μέτρο πρόληψης το οποίο βασίζεται σε ενδείξεις (evidence-based) και που αφορά τις λοιμώξεις που σχετίζονται με παρουσία κεντρικού φλεβικού καθετήρα (*Central Line Associated Bloodstream Infections*-**CLABSIs)** όταν **αλλάζετε** το επίθεμα ενός κεντρικού καθετήρα ή όταν **χειρίζεστε** αυτόν για να χορηγήσετε φάρμακα, διαλύματα κα. Παρακαλώ, κυκλώστε τον αριθμό στην κάθε ερώτηση ή οποία περιγράφει καλύτερα την πρακτική σας.

<u>Παράδειγμα</u>

1	**2**	**3**	**4**	**5**	**6**	**7**
ποτέ			τις μισές φορές			κάθε φορά

1. Πόσο συχνά **πλένετε ή απολυμαίνετε τα χέρια** σας πριν τον χειρισμό ή περιποίηση ενός κεντρικού καθετήρα?

1	2	3	4	5	6	7
ποτέ			τις μισές φορές			κάθε φορά

2. Πόσο συχνά **απολυμαίνετε το σημείο εισόδου των αυλών ή των 3-ways** με αντισηπτικό (χλωρεξιδίνη, 70% αλκοόλη) κατά τον χειρισμό ή περιποίηση ενός κεντρικού καθετήρα?

1	2	3	4	5	6	7
ποτέ			τις μισές φορές			κάθε φορά

3. Πόσο συχνά **συνδέετε** στον κεντρικό καθετήρα **μόνο αποστειρωμένες** συσκευές?

1	2	3	4	5	6	7
ποτέ			τις μισές φορές			κάθε φορά

4. Πόσο συχνά **αλλάζετε τα επιθέματα** τα οποία είναι λερωμένα, υγρά ή έχουν ξεκολλήσει?

1	2	3	4	5	6	7
ποτέ			τις μισές φορές			κάθε φορά

5. Πόσο συχνά **αλλάζετε τα επιθέματα με άσηπτη τεχνική** χρησιμοποιώντας καθαρά η αποστειρωμένα γάντια?

1	2	3	4	5	6	7
ποτέ			τις μισές φορές			κάθε φορά

Ενότητα Δ

Οι παρακάτω δηλώσεις αναφέρονται στην εφαρμογή των μέτρων που βασίζονται σε ενδείξεις (evidence-based) όταν **αλλάζετε** το επίθεμα ενός κεντρικού καθετήρα ή όταν **χειρίζεστε** αυτόν για να χορηγήσετε φάρμακα, διαλύματα με στόχο τη μείωση των λοιμώξεων που σχετίζονται με παρουσία κεντρικού φλεβικού καθετήρα (*Central Line Associated Bloodstream Infections*-**CLABSIs).** Παρακαλώ, διαβάστε προσεκτικά την κάθε δήλωση και απαντήστε κυκλώνοντας τον αριθμό που εκφράζει καλύτερα την άποψη σας. Μερικές δηλώσεις ίσως σας φαίνονται παρόμοιες, παρόλα αυτά εξετάζουν κατά κάποιο τρόπο διαφορετικά θέματα.

Παράδειγμα

		1	2	3	4	5	6	7	
α.	Εύκολη πρακτική	1	2	3	4	5	6	7	Δύσκολη πρακτική
β.	Διαφωνώ απόλυτα	1	2	3	4	5	6	7	Συμφωνώ απόλυτα

1-4.	Γενικά, νομίζω ότι η εφαρμογή των προληπτικών μέτρων κατά τη διάρκεια περιποίησης ή χειρισμού ενός κεντρικού καθετήρα προκειμένου να προληφθούν οι λοιμώξεις- **CLABSIs** είναι:	Εύκολη πρακτική	1	2	3	4	5	6	7	Δύσκολη πρακτική
		Σημαντική πρακτική	1	2	3	4	5	6	7	Μη σημαντική πρακτική
		μη απαραίτητη πρακτική	1	2	3	4	5	6	7	Απαραίτητη πρακτική
		καλή πρακτική	1	2	3	4	5	6	7	κακή πρακτική

5. Η εφαρμογή των προληπτικών μέτρων κατά τη διάρκεια περιποίησης ή χειρισμού ενός κεντρικού καθετήρα μειώνει το κόστος θεραπείας.

Διαφωνώ απόλυτα	1	2	3	4	5	6	7	Συμφωνώ απόλυτα

6. Η εφαρμογή των προληπτικών μέτρων κατά τη διάρκεια περιποίησης ή χειρισμού ενός κεντρικού καθετήρα μειώνει τη συχνότητα των λοιμώξεων- **CLABSIs**.

Διαφωνώ απόλυτα	1	2	3	4	5	6	7	Συμφωνώ απόλυτα

7. Η εφαρμογή των προληπτικών μέτρων κατά τη διάρκεια περιποίησης ή χειρισμού ενός κεντρικού καθετήρα θα αποτρέψει τον αποικισμό του κεντρικού καθετήρα. Διαφωνώ απόλυτα **1** **2** **3** **4** **5** **6** **7** Συμφωνώ απόλυτα
8. Η εφαρμογή των προληπτικών μέτρων κατά τη διάρκεια περιποίησης ή χειρισμού ενός κεντρικού καθετήρα συμβάλλει στην εφαρμογή μιας καθορισμένης διαδικασίας (τυποποίηση). Διαφωνώ απόλυτα **1** **2** **3** **4** **5** **6** **7** Συμφωνώ απόλυτα
9. Η εφαρμογή των προληπτικών μέτρων κατά τη διάρκεια περιποίησης ή χειρισμού ενός κεντρικού καθετήρα μειώνει τη διάρκεια παραμονής των ασθενών στη ΜΕΘ. Διαφωνώ απόλυτα **1** **2** **3** **4** **5** **6** **7** Συμφωνώ απόλυτα
10.Η εφαρμογή των προληπτικών μέτρων κατά τη διάρκεια περιποίησης ή χειρισμού ενός κεντρικού καθετήρα μειώνει τη σπατάλη αναλώσιμων υλικών (καθετήρας, επιθέματα κα). Διαφωνώ απόλυτα **1** **2** **3** **4** **5** **6** **7** Συμφωνώ απόλυτα
11.Οι συνάδελφοι των οποίων τη γνώμη εκτιμώ, νομίζουν ότι δεν θα πρέπει να εφαρμόζω τα προληπτικά μέτρα όταν περιποιούμαι ή χειρίζομαι έναν κεντρικό καθετήρα. Διαφωνώ απόλυτα **1** **2** **3** **4** **5** **6** **7** Συμφωνώ Απόλυτα

12.Η εφαρμογή των προληπτικών μέτρων κατά τη διάρκεια περιποίησης ή χειρισμού ενός κεντρικού καθετήρα είναι χρονοβόρος διαδικασία.

Διαφωνώ απόλυτα	**1**	**2**	**3**	**4**	**5**	**6**	**7**	Συμφωνώ απόλυτα

13.Η έλλειψη νοσηλευτικού προσωπικού με εμποδίζει στην εφαρμογή των προληπτικών μέτρων όταν περιποιούμαι ή χειρίζομαι έναν κεντρικό καθετήρα.

Διαφωνώ απόλυτα	**1**	**2**	**3**	**4**	**5**	**6**	**7**	Συμφωνώ απόλυτα

14.Η εφαρμογή μιας καθορισμένης διαδικασίας (τυποποίηση) κατά την περιποίησης ή χειρισμού ενός κεντρικού καθετήρα, είναι επιθυμητή.

Διαφωνώ απόλυτα	**1**	**2**	**3**	**4**	**5**	**6**	**7**	Συμφωνώ απόλυτα

Ενότητα Δ (*συνέχεια*)

Οι παρακάτω δηλώσεις αναφέρονται στην εφαρμογή των μέτρων που βασίζονται σε ενδείξεις (evidence-based) κατά τη διάρκεια της **τοποθέτησης** ενός κεντρικού καθετήρα με στόχο τη μείωση των λοιμώξεων που σχετίζονται με παρουσία κεντρικού φλεβικού καθετήρα (*Central Line Associated Bloodstream Infections*-**CLABSIs).** Παρακαλώ, διαβάστε προσεκτικά την κάθε δήλωση και απαντήστε κυκλώνοντας τον αριθμό που εκφράζει καλύτερα την άποψη σας. Μερικές δηλώσεις ίσως σας φαίνονται παρόμοιες, παρόλα αυτά εξετάζουν κατά κάποιο τρόπο διαφορετικά θέματα.

15.Ο Προϊστάμενος μου με επαινεί όταν εφαρμόζω τα προληπτικά μέτρα κατά τη διάρκεια περιποίησης ή χειρισμού ενός κεντρικού καθετήρα.

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Διαφωνώ απόλυτα	**1**	**2**	**3**	**4**	**5**	**6**	**7**	Συμφωνώ απόλυτα

16.Η αποφυγή αποικισμού του κεντρικού καθετήρα ως αποτέλεσμα της εφαρμογής των προληπτικών μέτρων κατά τη διάρκεια περιποίησης ή χειρισμού ενός κεντρικού καθετήρα, είναι επιθυμητή.

Διαφωνώ απόλυτα	**1**	**2**	**3**	**4**	**5**	**6**	**7**	Συμφωνώ απόλυτα

17.Οι συνάδελφοι των οποίων τη γνώμη εκτιμώ θα με επαινέσουν όταν εφαρμόζω τα προληπτικά μέτρα κατά τη διάρκεια περιποίησης ή χειρισμού ενός κεντρικού καθετήρα.

Διαφωνώ απόλυτα	**1**	**2**	**3**	**4**	**5**	**6**	**7**	Συμφωνώ απόλυτα

18.Η χρονική καθυστέρηση κατά τη διάρκεια περιποίησης ή χειρισμού ενός κεντρικού καθετήρα ως αποτέλεσμα της εφαρμογής των προληπτικών μέτρων, είναι ανεπιθύμητη.

Διαφωνώ απόλυτα	**1**	**2**	**3**	**4**	**5**	**6**	**7**	Συμφωνώ Απόλυτα

19.Η μείωση της συχνότητας των λοιμώξεων-**CLABSIs** με την εφαρμογή των προληπτικών μέτρων κατά τη διάρκεια περιποίησης ή χειρισμού ενός κεντρικού καθετήρα, είναι επιθυμητή.

Διαφωνώ απόλυτα	**1**	**2**	**3**	**4**	**5**	**6**	**7**	Συμφωνώ απόλυτα

20.Προσδοκάται από εμένα να εφαρμόζω τα προληπτικά μέτρα όταν περιποιούμαι ή χειρίζομαι έναν κεντρικό καθετήρα. Διαφωνώ απόλυτα **1 2 3 4 5 6 7** Συμφωνώ απόλυτα
21.Η μείωση της διάρκειας παραμονής των ασθενών στη ΜΕΘ λόγω της εφαρμογής των προληπτικών μέτρων κατά τη διάρκεια περιποίησης ή χειρισμού ενός κεντρικού καθετήρα, είναι επιθυμητή. Διαφωνώ απόλυτα **1 2 3 4 5 6 7** Συμφωνώ απόλυτα
22.Οι συνάδελφοι μου νομίζουν ότι δεν θα πρέπει να εφαρμόζω τα προληπτικά μέτρα όταν περιποιούμαι ή χειρίζομαι έναν κεντρικό καθετήρα. Διαφωνώ απόλυτα **1 2 3 4 5 6 7** Συμφωνώ απόλυτα
23.Η μείωση του κόστους νοσηλείας με την εφαρμογή των προληπτικών μέτρων κατά τη διάρκεια περιποίησης ή χειρισμού ενός κεντρικού καθετήρα, είναι επιθυμητή. Διαφωνώ απόλυτα **1 2 3 4 5 6 7** Συμφωνώ απόλυτα

24.Για μένα, το να μην μπορώ να εφαρμόσω τα προληπτικά μέτρα όταν περιποιούμαι ή χειρίζομαι έναν κεντρικό καθετήρα ως αποτέλεσμα της έλλειψης νοσηλευτικού προσωπικού, είναι ανεπιθύμητο.

Διαφωνώ απόλυτα	1	2	3	4	5	6	7	Συμφωνώ απόλυτα

25.Με ενδιαφέρει τι νομίζουν οι συνάδελφοι μου ότι θα πρέπει να κάνω.

Διαφωνώ απόλυτα	1	2	3	4	5	6	7	Συμφωνώ απόλυτα

26.Η αποδοχή του Προϊσταμένου μου είναι σημαντική για μένα.

Διαφωνώ απόλυτα	1	2	3	4	5	6	7	Συμφωνώ απόλυτα

27.Η μείωση της σπατάλης αναλώσιμων υλικών (καθετήρας, επιθέματα κα) λόγω της εφαρμογής των προληπτικών μέτρων κατά τη διάρκεια περιποίησης ή χειρισμού ενός κεντρικού καθετήρα, είναι επιθυμητή.

Διαφωνώ απόλυτα	1	2	3	4	5	6	7	Συμφωνώ απόλυτα

Ενότητα Ε

Στην παρακάτω ενότητα ενδιαφέρομαι για **τις απόψεις σας σχετικά με το περιβάλλον της ΜΕΘ που εργάζεστε και το βαθμό ετοιμότητάς της να εφαρμόζει πρακτικές οι οποίες βασίζονται σε ενδείξεις (evidence- based).** *Παρακαλώ σημειώστε την άποψη σας ακόμη και εάν δεν έχετε συναντήσει ανάλογη περίπτωση.* Για κάθε περίπτωση επιλέξτε με ✓ το κατάλληλο κουτάκι.

Πόσο πιθανό είναι να ισχύει κάθε μία από τις περιπτώσεις που περιγράφονται παρακάτω	**Συμφωνώ Απόλυτα**	**Συμφωνώ**	**Διαφωνώ**	**Διαφωνώ Απόλυτα**
1. Τηρούνται τα όρια των ατομικών και επαγγελματικών σχέσεων μεταξύ των επαγγελματιών υγείας	•	•	•	•
2. Οι αποφάσεις σχετικά με τη φροντίδα και τη διαχείριση καταγράφονται σε έντυπα	•	•	•	•
3. Λαμβάνονται πρωτοβουλίες κατά την παροχή της φροντίδας	•	•	•	•
4. Όλες οι διαστάσεις της φροντίδας/θεραπείας βασίζονται στην πρακτική που βασίζονται σε ενδείξεις (*evidence based practice*)	•	•	•	•
5. Ο/Η Προϊστάμενος/μένη νοσηλευτής/τρια λειτουργεί ως πρότυπο σωστής πρακτικής	•	•	•	•
6. Οι επαγγελματίες υγείας δίνουν τη δυνατότητα στους ασθενείς να συμμετέχουν στις αποφάσεις που αφορούν στη φροντίδα τους ή στη θεραπεία τους	•	•	•	•
7. Η εκπαίδευση αποτελεί προτεραιότητα στη ΜΕΘ που εργάζεστε	•	•	•	•
8. Οι εργασιακές σχέσεις μεταξύ κλινικού και μη-κλινικού προσωπικού είναι καλές	•	•	•	•

9. Το προσωπικό ενημερώνεται για την πορεία των παραπόνων που υποβάλλονται	•	•	•	•
10. Οι επαγγελματίες υγείας στη διεπιστημονική ομάδα, αξιολογούν την εξειδικευμένη εμπειρία των συναδέλφων τους και συμμετέχουν ισότιμα στη λήψη αποφάσεων	•	•	•	•
11. Τα αποτελέσματα που προκύπτουν από εσωτερικούς ελέγχους και έρευνες χρησιμοποιούνται για τη βελτίωση της καθημερινής πρακτικής	•	•	•	•
12. Υπάρχει τακτική αξιολόγηση της απόδοσης η οποία επιτρέπει την αναθεώρηση των πρακτικών και τη θέσπιση νέων στόχων	•	•	•	•
13. Το προσωπικό έχει ξεκάθαρη στάση και απόψεις σχετικά με την παρεχόμενη προς τους ασθενείς φροντίδα	•	•	•	•
14. Οι ασθενείς ενθαρρύνονται να συμμετέχουν ενεργά στ θεραπευτικό πλάνο	•	•	•	•
15. Υπάρχει μεγάλος σεβασμός ως προς την προσωπικότητα και στα ατομικά δικαιώματα των ασθενών	•	•	•	•
16. Οι επαγγελματίες υγείας και το βοηθητικό προσωπικό κατανοούν ο ένας το ρόλο του άλλου	•	•	•	•
17. Οι αρχές της διοίκησης της ΜΕΘ που εργάζεστε είναι δημοκρατικές και συμμετοχικές	•	•	•	•
18. Οι ασθενείς έχουν πρόσβαση σε ενημερωτικό υλικό πχ έντυπα φυλλάδια	•	•	•	•

19. Οι επαγγελματίες υγείας συνεργάζονται με τους ασθενείς παρέχοντας τους εξατομικευμένη φροντίδα	•	•	•	•
20. Η φροντίδα που παρέχεται βασίζεται σε διεξοδική και ολοκληρωμένη εκτίμηση του ασθενή	•	•	•	•
21. Η διαχείριση των δυσκολιών και των προκλήσεων στη καθημερινή πράξη υποστηρίζεται από τους Προϊστάμενους ιατρούς/νοσηλευτές και την ιατρική/ νοσηλευτική διοίκηση	•	•	•	•
22. Προγραμματίζονται συζητήσεις ανάμεσα στους επαγγελματίες υγείας και τους ασθενείς	•	•	•	•
23. Η ανάπτυξη των δεξιοτήτων του προσωπικού αποτελεί βασική προτεραιότητα των προϊστάμενων ιατρών και νοσηλευτών.	•	•	•	•
24. Το προσωπικό χρησιμοποιεί διαδραστικές μεθόδους για την αξιολόγηση και τη βελτίωση της πρακτικής τους πχ. κλινική επίβλεψη, ενεργητική μάθηση, αναστοχαστική πρακτική (*reflective practice*)	•	•	•	•
25. Το νοσοκομείο δίνει μεγάλη σημασία στην αυτονομία του ιατρικού και νοσηλευτικού προσωπικού	•	•	•	•
26. Το προσωπικό αποδέχεται με ευαισθησία τις πολιτισμικές διαφορές	•	•	•	•
27. Το προσωπικό έχει πρόσβαση στην γνώση που βασίζεται σε ενδείξεις (*evidence-based*)	•	•	•	•
28. Οι ασθενείς έχουν τη δυνατότητα επιλογής του σχεδιασμού και της αξιολόγησης της φροντίδας και της θεραπείας τους	•	•	•	•

29. Οι επαγγελματίες υγείας έχουν τη δυνατότητα να συμβουλεύονται τους ειδικούς επαγγελματίες πχ λοιμωξιολόγο, ψυχολόγο, φαρμακοποιό	•	•	•	•
30. Οι επαγγελματίες υγείας έχουν τη δυνατότητα να βελτιώνουν τη πρακτική τους	•	•	•	•
31. Ο/Η Διευθυντής/τρια ιατρός και ο Προϊστάμενος/νη Νοσηλευτής/τρια δημιουργούν πρόσφορο περιβάλλον για την ανάπτυξη και ανταλλαγή ιδεών	•	•	•	•
32. Υπάρχουν διαθέσιμες κατευθυντήριες οδηγίες και πρωτόκολλα που βασίζονται στη βέλτιστη πρακτική πχ εμπειρίες ασθενών, κλινική εμπειρία και έρευνα	•	•	•	•
33. Οι ασθενείς συμμετέχουν στην αξιολόγηση της φροντίδας που τους παρέχεται.	•	•	•	•
34. Υπάρχουν διαθέσιμοι πόροι για την παροχή φροντίδας που βασίζεται σε ενδείξεις (*evidence based practice*)	•	•	•	•
35. Στο νοσοκομείο που εργάζεστε υπάρχει συναινετική διοίκηση	•	•	•	•
36. Οι επαγγελματίες υγείας έχουν κοινούς στόχους που σχετίζονται με τη φροντίδα των ασθενών	•	•	•	•
37. Οργανωμένα προγράμματα εκπαίδευσης είναι διαθέσιμα για όλους τους επαγγελματίες υγείας	•	•	•	•

Στην ενότητα που ακολουθεί θα ήθελα να μάθω μερικές πληροφορίες για εσάς και για το περιβάλλον εργασίας σας. Παρακαλώ σημειώστε √ στο αντίστοιχο κουτάκι.

Ηλικία__________ετών **Γυναίκα** • **Άντρας** •

Πόσο καιρό εργάζεστε σε αυτό το νοσοκομείο;__________έτη

Πόσο καιρό εργάζεστε στον τομέα της εντατικής θεραπείας;_______έτη

Ποια είναι η θέση διορισμού σας;

Προϊστάμενος/η • Νοσηλευτι •

Έχετε επιπλέον επαγγελματικά προσόντα;

Νοσηλευτική Ειδικότητα • •

Παρακαλώ περιγράψτε_____________________________

Ποιο είναι το ανώτατο πτυχίο εκπαίδευσή σας;

ΠΕ • ΑΤΕΙ • Μεταπτυχιακό • Διδακτορικό •

Σας ευχαριστώ πολύ που διαθέσατε χρόνο για να συμπληρώσετε το ερωτηματολόγιο αυτό.

Εάν έχετε οποιαδήποτε απορία που αφορά στην συμπλήρωση του, παρακαλώ επικοινωνήστε

με την Κατερίνα Ηλιοπούλου στο 2107494515-6 ή katerina.iliopoulou@kcl.ac.uk

Αν υπάρχει κάποια άλλο επιπλέον σχόλιο που θεωρείτε σημαντικό, παρακαλώ χρησιμοποιείστε τον παρακάτω χώρο:

____

____

____

____

____

____

APPENDIX 7: STRUCTURED OBSERVATION'S CHECKLISTS

Central venous catheter insertion observation checklist

Date of insertion: .... **Number of Observation: ....**

Shift: .... **Start time.......**

Physician's professional status

1st: Resident □ Physician assistant □ Specialized intensivist □ Other medical staff □

2nd Resident(assistant) □ Physician assistant □ Specialized intensivist □ Other medical staff □

Site of insertion: subclavian □ internal jugular □ femoral □

if femoral, why?...........................

Reason for insertion

Replace malfunctioning central line□ no prior central line □
Suspected central line-associated infection □ routine replacement □
Line was inserted in another ward □ Other (specify): ....

Was the central line exchanged over a guidewire? □ yes □ no

CHECKLIST

Hand hygiene: yes □ no □

All 5 maximal sterile barriers used: yes□ no □

Sterile gown yes □ no □

Cap yes □ no □

Mask yes □ no □

Sterile gloves yes □ no □

Large sterile drape: *yes* □ no □

Skin preparation: yes□ no □

CHX 2% gluconate □ Alcohol □ Povidone □ Other □

Duration of scrubbing...........sec (30sec)
Skin prep agent has completely dried at time of first skin puncture: yes □ no □

GENERAL INFORMATION

the procedure was: emergent □ no-emergent □

unsuccessful □

successful within 3 sticks □
successful in more than 3 sticks □
second operator □

Was the trolley utilized during insertion? yes □ no □
Everyone in the room/bedside wears mask yes □ no □
Did nurse go away to bring more supplies? yes □ no □

Maintain sterile technique **during procedure** yes □ no □
Maintain sterile technique when applying sterile dressing yes □ no □

Central venous catheter handling observation checklist

Date: **Time**: 8am-12pm-16.00pm-20.00pm **Bed**: 1-2-3-4-5-6-7-8-9 -10 **HCW**:P/N	**Date**: **Time**: 8am-12pm-16.00pm-20.00pm **Bed**: 1-2-3-4-5-6-7-8-9 -10 **HCW**:P/N
BI□ IVI □ MedA□ LI□ CVP□ BW □ FL□	BI□ IVI □ MedA□ LI□ CVP□ BW □ FL□
*Use **hand hygiene**:* *yes ☐ no ☐* *Use **clean gloves**:* *yes ☐ no ☐* ***Maintain ANTT:*** *yes ☐ no ☐* ***Scrub the hub**:* *CHX* +Alcohol □ Other□ none☐ ***Access only with*** ***sterile IV** devices:* *yes ☐ no ☐ not observed☐*	*Use **hand hygiene**:* *yes ☐ no ☐* *Use **clean gloves**:* *yes ☐ no ☐* ***Maintain ANTT:*** *yes ☐ no ☐* ***Scrub the hub**:* *CHX* +Alcohol □ Other□ none☐ ***Access only with*** ***sterile IV** devices:* *yes ☐ no ☐ not observed☐*

Central venous catheter site care observation checklist

Date: **Time**: .... **Bed**: 1-2-3-4-5-6-7-8-9	**Date**: **Time**: .... **Bed**: 1-2-3-4-5-6-7-8-9
*Use **hand hygiene**:* *yes ☐ no ☐* *Use **clean gloves**:* *yes ☐ no ☐* *Use **sterile gloves:*** *yes ☐ no ☐* ***Skin disinfection:*** *CHX* ☐+ Alcohol □ (Hibitane) Other □ none ☐ **Apply sterile dressing:** transparent (7d) ☐ gauze (2-3d) ☐	*Use **hand hygiene**:* *yes ☐ no ☐* *Use **clean gloves**:* *yes ☐ no ☐* *Use **sterile gloves:*** *yes ☐ no ☐* ***Skin disinfection:*** *CHX* ☐+ Alcohol □ (Hibitane) Other □ none ☐ **Apply sterile dressing:** transparent (7d) ☐ gauze (2-3d) ☐
if gauze applied was there bleeding or oozing? yes □ no □ Transparent dressing was not available □ not desirable □ Dressing and catheter covered during bath? yes □ no □ Palpation for signs of inflammation yes ☐ no☐	if gauze applied was there bleeding or oozing? yes □ no □ Transparent dressing was not available □ not desirable □ Dressing and catheter covered during bath? yes □ no □ Palpation for signs of inflammation yes ☐ no☐

APPENDIX 8: Centers for Disease Control and Prevention Definitions for Central Line-Associated Bloodstream Infection Terminology (2012)

Terminology	Definition
Central Line Associated Bloodstream Infections	An LCBI where a central line was in place for >2 calendar days and a central line was in place on the date of event or the day before.
Laboratory Confirmed Bloodstream Infections	To be defined as LCBI, it must meet 1 of the following criteria: (1) Patient has a recognized pathogen cultured from 1 or more blood cultures, and organism cultured from blood is not related to an infection at another site; (2) Patient has at least 1 of the following signs or symptoms: fever (>38°C), chills, or hypotension, **and** positive laboratory results are not related to an infection at another site and the same common commensal is cultured from 2 or more blood cultures drawn on separate occasions.
Central line days	A daily count of the number of patients with a central line in the patient care location during a time period. A patient with multiple central lines for a day only counts as 1 central line day.
Patient-days .	A daily count of the number of patients in the patient care location during a time period.
Device utilization ratio .	Central line utilization ratio is calculated by dividing the number of central line days by the number of patient-days.

APPENDIX 9: OBSERVATION SCHEDULE USED DURING THE BASELINE ASSESSMENT

Date of observation: .... Time: .... Duration: ....

AVAILAIBLE EQUIPMENT IN RELATION TO CLABSI PREVENTION

Sterile dressings: transparent: Y-N	Gauze: Y-N
Disposable hubs: Y-N	Clean gloves: Y-N Sterile gloves: Y-N
How many?	....
Antiseptic solutions? Y-N Other barrier related to equipment? Is the CLABSI prevention equipment located in the ICU or out of the ICU?	CHX 2%? Y-N .... Y-N Comments:

Date of observation: .... Time: .... Duration: ....

ICU SETTING

Sinks: Where are they located in relation to ICU bed spaces?	Is there an IV medication trolley? Y-N
Layout of bed-spaces:	
Where the CVC insertion equipment is located?	In the ICU: Y-N Out of the ICU: Y-N
Is there enough space for HCWs to move around the bed-space?	Y-N
Other barriers related to ICU setting?	Comments: ....

Date of observation: .... Time: .... Duration: ....

HEALTH CARE WORKERS in relation to CVC INSERTION

Who is in the bed-space during a CVC insertion?	
Is everybody allowed to be present during a CVC insertion?	
What is the role of each person during the insertion of a CVC?	
Are nurses empowered to stop the procedure if a preventive measure is not properly implemented?	
Does the nurse pay attention how the CVC is inserted, or she/he just wait to be asked to serve the appropriate equipment?	
In case, CVC insertion takes longer time that it is anticipated, what the assistant nurse does during that time?	
Does the latter follow a recurrent behavior?	
Overall is there a communication between physicians and nurses during an insertion of a CVC?	
Other comments:......................	

Date of observation: .... Time: .... Duration:.................

HEALTH CARE WORKERS in relation to CVC HANDLING

Does the nurse have the time to organize properly the supplies and equipment prior to CVC handling?	

Who is available to assist in case something that has not been anticipated, does occur during CVC handling?	
Who is accessing the CVC?	
Who is accountable for handling a CVC correctly?	
Is there clinical supervision during CVC handling, for the less experienced nurses? If no, why?	
Is there a specific policy for handling the IV drips when a patient is transported out of the ICU and these drips are disconnected from the patient?	
When a patient returns from a diagnostic assessment how many nurses connect the IV drips with the patients' CVC lumens?	
Other comments:	

Date of observation: .... Time: .... Duration: ....

HEALTH CARE WORKERS in relation to CVC SITE CARE

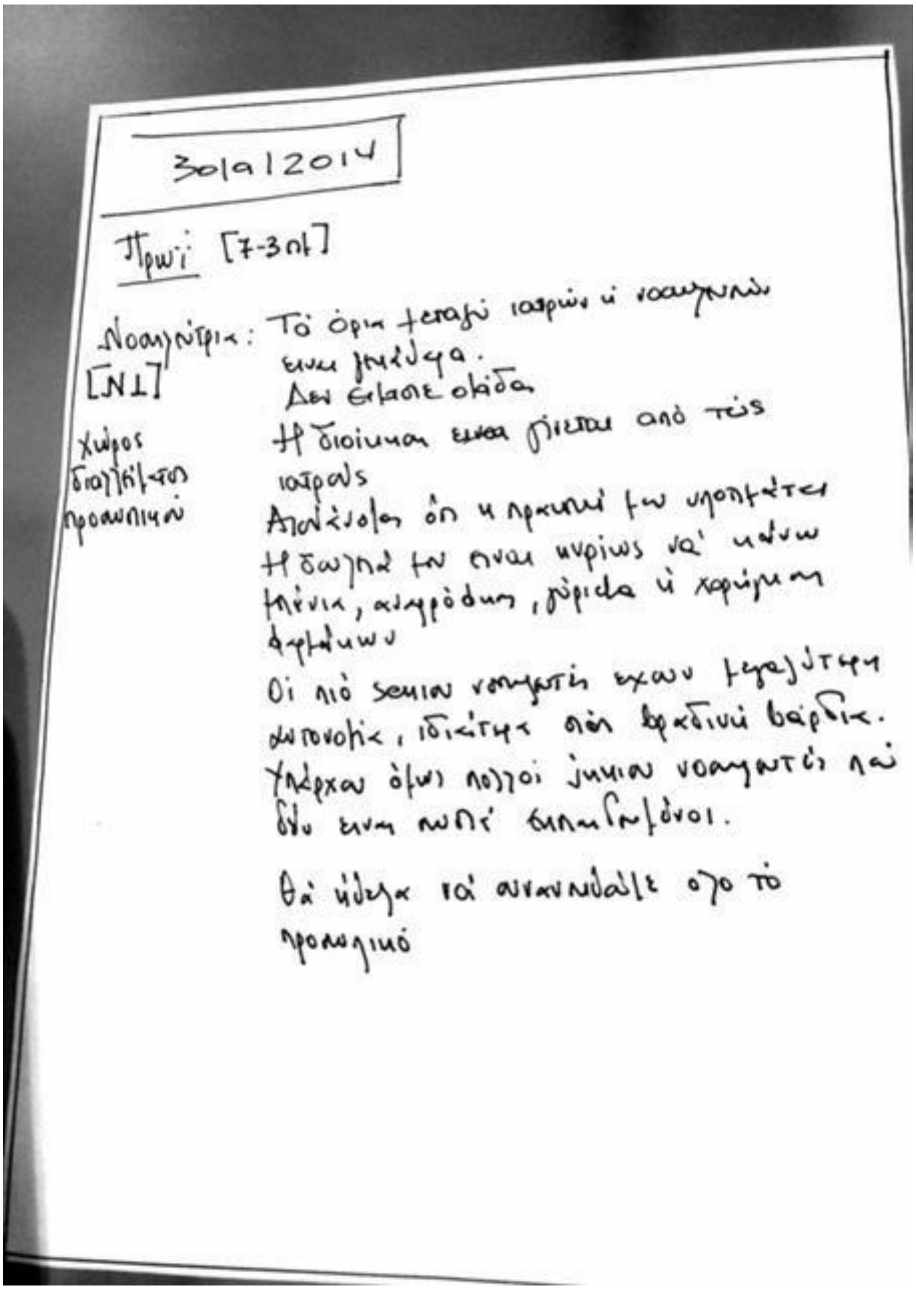
Does the nurse organize properly the supplies and equipment prior to CVC dressing change?	
Do nurses record how the CVC site looks like when they replace the dressing?	
Do nurses record the date of dressing change? Where?	
Is there a clinical supervision during CVC dressing change, for the less experienced nurses? If no, why?	
Other comments:	

Date of observation: .... Time: .... Duration: ....

PROCESSES in place related to CLABSI prevention

Where is it documented that a patient has CLABSI?	
Is there an infection nurse within the ICU? Is there an infection preventionist physician? Who is responsible for CLABSI surveillance?	
Is there an in-service education related to CLABSI prevention?	
Are the CLABSI guidelines available within the ICU? If yes, are they easily accessible?	
Is there a separate section in patient's daily chart where CVC's characteristics? are described?	
If yes, whose responsibility is to record the above?	
Do physicians and nurses exchange information about patient's CVC?	
Who reports the information related to patient's CVC during the ward round? Are nurses asked to provide the above information during the ward round? If no, what nurses do believe about this?	
Other comments:	

APPENDIX 10: EXAMPLE OF CONTEMPORANEOUS FIELD NOTES



30/9/2014

Πρωί [7-3μμ]

Νοσηλεύτρια: [N1]
Τα όρια μεταξύ ιατρών και νοσηλευτών είναι μεγάλα.
Δεν είμαστε ομάδα
Η διοίκηση είναι μόνο από τους ιατρούς

Χώρος διαλείμματος προσωπικού

Αισθάνομαι ότι η πρακτική μου υποτιμάται
Η δουλειά μου είναι κυρίως να κάνω μπάνια, αλλαγές, γύρισμα και χορήγηση φαρμάκων

Οι πιο senior νοσηλευτές έχουν μεγαλύτερη αυτονομία, ιδιαίτερα στη βραδινή βάρδια.
Υπάρχουν όμως πολλοί junior νοσηλευτές και δεν είναι πολύ ευχαριστημένοι.

Θα ήθελα να αναπτυχθεί στο το προσωπικό

APPENDIX 11: WRITTEN INFOMATION PROVIDED TO RESEARCH'S PARTICIPANTS IN ENGLISH AND GREEK LANGUAGE

INFORMATION SHEET FOR PARTICIPANTS

YOU WILL BE GIVEN A COPY OF THIS INFORMATION SHEET

A quality improvement initiative aiming at reducing Central Line Associated Bloodstream Infections in a medical intensive care unit: a pilot study.

We would like to invite you to participate in this postgraduate research project. You should only participate if you want to; choosing not to take part will not disadvantage you in any way. Before you decide whether you want to take part, it is important for you to understand why the research is being done and what your participation will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask me if there is anything that is not clear or if you would like more information.

- The aim of the questionnaire is to identify the current practices on central line associated infections (CLABSI) in your unit and to identify also your views on CLABSI infection control.
- The project is funded by the researcher.
- All physicians and registered critical care nurses who work in the ICU will be included in the study.
- It is expected that participants will not experience any risk, or any kind of inconveniency or discomfort associated to the proposed study.
- All provided questionnaires will be anonymous. Observation data will also remain anonymous and no other identifying data will be collected from them. Additionally, during the data analysis all data will be kept in the researcher's personal computer which is password protected
- Submission of a completed questionnaire implies consent to participate.
- If you do decide to take part, you will be given this information sheet to keep and be asked to sign a consent form.
- As participation is anonymous it will not be possible for us to withdraw your data once you have returned your questionnaire.
- The main findings of the study will be announced to all HCWs of your unit in the second semester in 2015

If you have any questions or require more information about this study, please contact the researcher using the following contact details: Katerina Iliopoulou, ICU Nurse Manager, Army Hospital, Athens

Tel: 2107494516, email: katerina.iliopoulou@kcl.ac.uk

If this study has harmed you in any way, you can contact King's College London using the details below for further advice and information: Dr Janet Anderson, janet.anderson@kcl.ac.uk

Thank you,

Katerina Iliopoulou

King's College London
University of London

ΕΝΗΜΕΡΩΤΙΚΟ ΔΕΛΤΙΟ ΓΙΑ ΤΟΥΣ ΣΥΜΜΕΤΕΧΟΝΤΕΣ ΣΤΗΝ ΕΡΕΥΝΑ ΜΕ ΤΙΤΛΟ:

"Πρωτοβουλία βελτίωσης ποιότητας η οποία στοχεύει στη μείωση των λοιμώξεων αιματικής ροής σχετιζόμενων με παρουσία κεντρικού φλεβικού καθετήρα" (πρωτότυπος τίτλος: *Quality improvement initiative aiming at reducing Central Line Associated Bloodstream Infections-CLABSIs)*

WHO CONDUCTS THE PRESENT RESEARCH? Η πρωταρχική ερευνήτρια της μελέτης είναι μέλος του Διδακτικού Προσωπικού του Πανεπιστημίου King's College του Λονδίνου, Dr Janet Anderson (janet.anderson@kcl.ac.uk). Μπορείτε να επικοινωνήστε μαζί της σε περίπτωση που η έρευνα θεωρείτε ότι μπορεί να σας βλάψει κατά κάποιο τρόπο καθώς και για περαιτέρω επεξηγήσεις.
Η συν-ερευνήτρια Ηλιοπούλου Κατερίνα, είναι νοσηλεύτρια ΜΕΘ και διδακτορική φοιτήτρια η οποία διεξάγει την έρευνα αυτή σαν μέρος της διδακτορικής της διατριβής. Μπορείτε να επικοινωνείτε μαζί της για ερωτήσεις που ίσως έχετε (katerina.iliopoulou@kcl.ac.uk/ 210-7494516-515).

WHY AM I INVITED TO PARTICIPATE IN THE PRESENT RESEARCH? Οι αυξημένοι δείκτες CLABSIs συνδέονται με αυξημένη θνησιμότητα και αύξηση του κόστους θεραπείας. Τα γνωστά έως τώρα δεδομένα έχουν αποκαλύψει ότι οι δείκτες CLABSIs στην Ελλάδα είναι υψηλότεροι από τους αντίστοιχους στην Ευρώπη και τις Ηνωμένες Πολιτείες της Αμερικής. Θέλουμε να εξετάσουμε εάν η ανάπτυξη μιας πολυδιάστατης, εξατομικευμένης παρέμβασης που βασίζεται στη θεωρία της *αιτιολογημένης δράσης*, θα μείωνε την συχνότητα των CLABSIs στη ΜΕΘ όπου εργάζεστε. Επιπλέον, πιστεύουμε ότι οι απόψεις σας και η γνώμη σας θα είναι πολύ σημαντικές για την έρευνα μας.

WHAT IS THE PURPOSE OF THE PRESENT RESEARCH? Ο σκοπός της έρευνας είναι να εξετάσουμε τις τρέχουσες πρακτικές που αφορούν στα μέτρα πρόληψης των CLABSIs καθώς και τα εμπόδια κ τους διευκολυντικούς παράγοντες της συμμόρφωσης του ιατρο-νοσηλευτικού προσωπικού με τα μέτρα πρόληψης. Τα αποτελέσματα θα χρησιμοποιηθούν για να σχεδιαστεί μια εξατομικευμένη, πολυδιάστατη παρέμβαση η οποία θα δοκιμαστεί πιλοτικά και θα στοχεύει στη μείωση των CLABSIs στη ΜΕΘ όπου εργάζεστε.

HOW DATA WILL BE COLLECTED? Τα δεδομένα της μελέτης θα συλλεχθούν σε δύο περιόδους (1η και 3η φάση). Στην 1η περίοδο (διαγνωστική φάση) θα συλλεχθούν δεδομένα που θα σχετίζονται με: τις τρέχουσες πρακτικές εισαγωγής και φροντίδας κεντρικών καθετήρων, την μηνιαία συχνότητα των CLABSIs, καθώς και με το περιβάλλον της ΜΕΘ σε επίπεδο πρόληψης των λοιμώξεων. Αυτά τα δεδομένα θα βοηθήσουν στον σχεδιασμό από την ερευνήτρια μιας εξατομικευμένης, παρεμβατικής πρωτοβουλία βελτίωσης της ποιότητας (φάση σχεδιασμού) με στόχο την μείωση των δεικτών CLABSI στη ΜΕΘ όπου εργάζεστε. Στην 3η περίοδο (φάση υλοποίησης) θα δοκιμαστεί η προτεινόμενη παρεμβατική διαδικασία με σκοπό να εξεταστεί η αποδοχή, η αποτελεσματικότητα της, η συνοχή και η σκοπιμότητα της. Τα δεδομένα και στις 2 φάσεις θα συλλεχθούν μέσω παρατήρησης και ερωτηματολογίων. Οι πρακτικές των ιιατρών και νοσηλευτών κατά την εισαγωγή και περιποίηση των κεντρικών καθετήρων θα παρατηρηθούν από την ερευνήτρια παράλληλα με τις εφαρμοζόμενες πολιτικές πρόληψης των λοιμώξεων. Δέκα περιπτώσεις εισαγωγής και δέκα περιπτώσεις περιποίησης τουλάχιστον, πρόκειται να παρατηρηθούν με τη βοήθεια μιάς δομημένης λίστας ελέγχου (CDC's, 2011- checklist). Η παρατηρήτρια, η οποία δεν θα παρεμβαίνει, θα έχει την ευκαιρία να προσδιορίσει και να περιγράψει συναφείς επιρροές οι οποίες θα είναι σημαντικές πηγές για την μη συμμόρφωση του προσωπικού με την εφαρμογή των προληπτικών τεκμηριωμένων μέτρων κατά των CLABSIs . Η παρατήρηση θα πραγματοποιηθεί σε μια περίοδο 20 ημερών περίπου, κατά την διάρκεια της πρωινής ή απογευματινής βάρδιας, 4ώρες περίπου σε καθημερινή βάση, ώστε η ερευνήτρια να αποκτήσει μια ισορροπημένη κατανομή περιόδων παρατήρησης, για όλο το σύνολο των συμμετεχόντων. Ο δεύτερος τρόπος συλλογής των δεδομένων αφορά στη συμπλήρωση ερωτηματολογίων για τις αναφερόμενες πρακτικές κατά την εισαγωγή και περιποίηση των κεντρικών καθετήρων καθώς και στην διερεύνηση των πιθανών εμποδίων που αναστέλλουν την συμμόρφωση των ιατρών και νοσηλευτών με τα τεκμηριωμένα (evidence-based) μέτρα πρόληψης των CLABSIs.

HOW LONG DATA COLLECTION WILL LAST? Τα δεδομένα από την παρατήρηση θα συλλεχθούν κατά την 1η φάση καθώς και τον 1ο και 6ο μήνα της τρίτης φάσης. Η πρώτη φάση της έρευνας θα διαρκέσει έως τις 8 Αυγούστου 2014, ενώ η 3η φάση θα ξεκινήσει περίπου στα μέσα Νοεμβρίου 2014 και θα διαρκέσει έως τα τέλη Μαίου 2015.

WHO WILL HAVE ACCESS TO COLLECTED DATA? Όλα τα ερωτηματολόγια θα είναι **ανώνυμα** και τα δεδομένα που θα συλλεχθούν από αυτά θα είναι **εμπιστευτικά** σε όλες τις φάσεις της μελέτης. Τα δεδομένα της παρατήρησης θα είναι επίσης εμπιστευτικά και **δεν θα αποκαλυφθούν** σε τρίτους με τρόπο που να μπορεί να γίνει ταυτοποίηση. Τα δεδομένα της μελέτης ίσως δημοσιευτούν σε επιστημονικά περιοδικά και θα χρησιμοποιηθούν για διδακτικούς σκοπούς. Παρολαυτά, προκειμένου να εντοπιστούν και να αποσυρθούν τα δεδομένα που σας αφορούν σε περίπτωση που θελήσετε να αποσυρθείτε κάποια στιγμή από την έρευνα, θα υπάρχει αντιστοιχία της ταυτότητας σας με ένα κωδικό που θα τον γνωρίζετε μόνο εσείς και τον οποίο θα αναγράψετε στο επάνω μέρος της πρώτης σελίδας των ερωτηματολογίων και στο checklist της παρατήρησης.

SHOULD I PARTICIPATE TO THE PRESENT RESEARCH? Η συμμετοχή σας θα είναι πολύ σημαντική για την μελέτη παρόλα αυτά, δεν έχετε καμιά υποχρέωση συμμετοχής. Μπορείτε να αποσυρθείτε οποιαδήποτε στιγμή το αποφασίσετε κατά τη διάρκεια συλλογής των δεδομένων, αφού ειδοποιήσετε την ερευνήτρια, χωρίς αυτό να έχει επιπτώσεις στον τρόπο εργασίας σας. Η διορία για να αποσυρθούν τα δεδομένα παρατήρησης που έχουν ήδη συλλεχθεί από τους συμμετέχοντες θα είναι η 7/08/2014 (θα συμπεριλαμβάνεται και η συγκεκριμένη μέρα). Μετά από αυτήν την ημερομηνία δεν θα είναι δυνατόν να εντοπιστούν τα δεδομένα που σας αφορούν και να αποσυρθούν από την βάση δεδομένων.

IS THERE ANY RISK FROM MY PARTIICPATING IN THE PRESENT RESEARCH? Όλοι οι ατροί και οι νοσηλευτές της που εργάζονται στην ΜΕΘ πληρούν τις προυποθέσεις συμμετοχής. Αναμένεται να μην έχετε κανέναν κίνδυνο ή καμία είδους ενόχληση που να σχετίζετε με την προτεινόμενη έρευνα. Αν θεωρήσετε ότι η έρευνα σας βλάπτει με οποιοδήποτε τρόπο, μπορείτε να επικοινωνήσετε με το King’s College, London για περαιτέρω συμβουλές και πληροφορίες: Dr Janet Anderson janet.anderson@kcl.ac.uk.

IS THERE ANY BENEFIT FROM MY PARTICPATING IN THE PRESENT RESEARCH? Δεν μπορούμε να υποσχεθούμε ότι η έρευνα αυτή θα σας ωφελήσει ατομικά, ελπίζουμε όμως ότι τα δεδομένα της έρευνας ίσως βελτιώσουν τη συμμόρφωση του προσωπικού με τα τεκμηριωμένα μέτρα πρόληψης των CLABSIs κ συνεπώς τη μείωση αυτών.

Μπορείτε να κρατήσετε αυτό το ενημερωτικό έντυπο για την πληροφόρησή σας. Θα επισκέπτομαι την ΜΕΘ για τις επόμενες 2 έως 3 μέρες και αν τελικά αποφασίσετε να πάρετε μέρος σε αυτήν την έρευνα θα σας ζητηθεί να υπογράψετε ένα συναινετικό έντυπο τόσο για την συμπλήρωση των ερωτηματολογίων όσο και για την περίοδο της παρατήρησης.

Αν έχετε οποιαδήποτε απορία ή χρειάζεστε περισσότερες πληροφορίες για την έρευνα παρακαλώ επικοινωνήστε με την ερευνήτρια χρησιμοποιώντας τις παρακάτω πληροφορίες επικοινωνίας

Θα ήθελα να σας ευχαριστήσω εκ των προτέρων για την συνεργασία σας.

Κατερίνα Ηλιοπούλου

Email: katerina.iliopoulou@kcl.ac.uk **Τηλέφωνο επικοινωνίας**: 210-6775679

Σημείωση: η συγκεκριμένη έρευνα χρηματοδοτείται από την ερευνήτρια

APPENDIX 12: CONSENT FORM SIGNED BY ALL PARTICIPANTS IN ENGLISH AND IN GREEK LANGUAGE

CONSENT FORM FOR PARTICIPANTS IN RESEARCH STUDIES

KING'S College LONDON

Please complete this form after you have read the Information Sheet and/or listened to an explanation about the research.

Title of Study: A quality improvement initiative aiming at reducing Central Line Associated Bloodstream Infections in a medical intensive care unit: a pilot study''.

King's College Research Ethics Committee Ref: ***PNM/13/14-78***______________

Thank you for considering taking part in this research. The person organising the research must explain the project to you before you agree to take part. If you have any questions arising from the Information Sheet or explanation already given to you, please ask the researcher before you decide whether to join in. You will be given a copy of this Consent Form to keep and refer to at any time.

- I understand that if I decide at any time during the research that I no longer wish to participate in this project, I can notify the researchers involved and withdraw from it immediately without giving any reason.
- I consent to the processing of my personal information for the purposes explained to me. I understand that such information will be handled in accordance with the terms of the UK Data Protection Act 1998.
- The information you have submitted will be published as a report; please indicate whether you would like to receive a copy.

Yes	No

- I understand that confidentiality and anonymity will be maintained, and it will not be possible to identify me in any publications

Yes	No

- I agree that the research team may use my data for future research and understand that any such use of identifiable data would be reviewed and approved by a research ethics committee.

Yes	No

- I consent to being observed

Yes	No

Participant's Statement:

I ____ agree that the research project named above has been explained to me to my satisfaction and I agree to take part in the study. I have read both the notes written above and the Information Sheet about the project and understand what the research study involves.

Signed Date

Investigator's Statement:

I ____

Confirm that I have carefully explained the nature, demands and any foreseeable risks (where applicable) of the proposed research to the participant.

Signed Date

Αποδοχή έρευνας σύμφωνα με, King's College, Research Ethics Committee Ref: PNM/13/14-78

KING'S College LONDON

ΕΝΤΥΠΟ ΕΝΥΠΟΓΡΑΦΗΣ ΣΥΝΑΙΝΕΣΗΣ ΣΥΜΜΕΤΕΧΟΝΤΩΝ

Παρακαλώ πολύ όπως συμπληρώσετε το παρακάτω έντυπο αφού έχετε διαβάσσει το ενημερωτικό έντυπο προς τους συμμετέχοντες στην έρευνα με τίτλο: ''πρωτοβουλία βελτίωσης ποιότητας η οποία στοχεύει στη μείωση των λοιμώξεων αιματικής ροής σχετιζόμενων με παρουσία κεντρικού φλεβικού καθετήρα"

Σας ευχαριστώ για το ενδιαφέρον σας να συμμετέχετε στην έρευνα αυτή. Εάν έχετε ερωτήσεις που προέκυψαν μετά την ανάγνωση του Ενημερωτικού Εντύπου, παρακαλώ απευθυνθείτε στην ερευνήτρια προτού αποφασίσετε να λάβετε μέρος. Παρακαλώ βάλτε √ στο αντίστοιχο κουτάκι.

- Καταλαβαίνω ότι εάν αποφασίσω οποιαδήποτε στιγμή να διακόψω, μπορώ να ειδοποιήσω την ερευνήτρια και να αποσυρθώ αμέσως χωρίς να δώσω κάποια εξήγηση. •
- Συναινώ στην επεξεργασία των προσωπικών μου δεδομένων για τους σκοπούς που εξηγήθηκαν σε εμένα. Καταλαβαίνω ότι αυτές οι πληροφορίες θα αντιμετωπιστούν σύμφωνα με τους όρους της Προστασίας Δεδομενων (UK Data Protection Act 1998). •
- Οι πληροφορίες που θα δώσετε θα δημοσιευτούν με τη μορφή αναφοράς, παρακαλώ σημειώστε εάν θα θέλατε να λάβετε ένα αντίγραφο. • ναι • όχι
- Καταλαβαίνω ότι η ανωνυμία και το απόρρητο των πληροφοριών θα διατηρηθούν και δεν θα είναι δυνατή η αναγνώριση μου σε οποιεσδήποτε δημοσιεύσεις. •
- Συμφωνώ ότι η ερευνητική ομάδα ίσως χρησιμοποιήσει τα δεδομένα για μελλοντική έρευνα και καταλαβαίνω ότι εάν αυτό γίνει θα πρέπει να δοδεί έγκριση ξανά από την Επιτροπή Ηθικής και Έρευνας του Πανεπιστημίου. •
- Συναινώ να παρατηρηθώ. •

Διάβασα την περιγραφή της μελέτης και είχα την ευκαιρία να λάβω επαρκείς απαντήσεις στις ερωτήσεις. Συμφωνώ να συμμετέχω στη μελέτη.

Ονοματεπώνυμο

συμμετέχοντα...Υπογραφή.....................

Ονοματεπώνυμο αυτού που λαμβάνει την συναίνεση Υπογραφή..................

APPENDIX 13: ETHICAL APPROVAL GRANTED FROM KING'S COLLEGE

Katerina Iliopoulou
Florence Nightingale School of Nursing and Midwifery

King's College London

James Clerk Maxwell Building

57 Waterloo Road

London SE1 8WA

02 June 2014

Dear Katerina,

PNM/13/14-78 A quality improvement initiative aiming at reducing Central Line Associated Bloodstream Infections in a medical intensive care unit: a pilot study

Review Outcome: Full Approval

Thank you for sending in the amendments/clarifications requested to the above project. I am pleased to inform you that these meet the requirements of the PNM RESC and therefore that full approval is now granted.

Provisos

Your approval is based on the following provisos being met:

1. Section 6.3: Consider whether it may be preferable for the gatekeeper organisation to distribute an e-mail on your behalf. This might mitigate pressure to participate.

2. Section 10e: Provide a departmental postal address for the location at which research data will be stored after the study.

You must provide evidence to the Committee that these provisos have been addressed prior to commencing your research.

Please ensure that you follow all relevant guidance as laid out in the King's College London Guidelines on Good Practice in Academic Research (http://www.kcl.ac.uk/college/policyzone/index.php?id=247).

For your information ethical approval is granted until 02 June 2017. If you need approval beyond this point you will need to apply for an extension to approval at least two weeks prior to this explaining why the extension is needed, (please note however that a full re-application will not be necessary unless the protocol has changed). You should also note that if your approval is for one year, you will not be sent a reminder when it is due to lapse.

Ethical approval is required to cover the duration of the research study, up to the conclusion of the research. The conclusion of the research is defined as the final date or event detailed in the study description section of your approved application form (usually the end of data collection when all work with human participants will have been completed), not the completion of data analysis or publication of the results.
For projects that only involve the further analysis of pre-existing data, approval must cover any period during which the researcher will be accessing or evaluating individual sensitive and/or un-anonymised records.
Note that after the point at which ethical approval for your study is no longer required due to the study being complete (as per the above definitions), you will still need to ensure all research data/records management and storage procedures agreed to as part of your application are adhered to and carried out accordingly.

If you do not start the project within three months of this letter, please contact the Research Ethics Office.

Should you wish to make a modification to the project or request an extension to approval you will need approval for this and should follow the guidance relating to modifying approved applications:
http://www.kcl.ac.uk/innovation/research/support/ethics/applications/modifications.aspx
Please would you also note that we may, for the purposes of audit, contact you from time to time to ascertain the status of your research.

If you have any query about any aspect of this ethical approval, please contact your panel/committee administrator in the first instance (http://www.kcl.ac.uk/innovation/research/support/ethics/contact.aspx)
We wish you every success with this work.

Yours sincerely, James Patterson – Senior Research Ethics Officer

Cc: Janet Anderson

APPENDIX 14: FORMAL LETTER THAT WAS SENT TO RESEARCH AND ADVISORY BOARD OF PARTICIPATING HOSPITALS IN ORDER TO GAIN LOCAL ACCESS IN ENGLISH AND GREEK LANGUAGE

Dear Sir/Madam

My name is Katerina Iliopoulou, and I am appointed as nurse manager at the critical care unit of the 401 Military Hospital in Athens, Greece. I am also preparing my thesis dissertation for the Doctorate in Health Care at King´s College, London, UK.

The subject of my thesis is ‘' A quality improvement initiative aiming at reducing Central Line Associated Bloodstream Infections in a medical intensive care unit: a pilot study''. This study is important because CLABSI rates in Greece are higher than the ones reported in Europe and USA and such high rates have an impact on patients' mortality, length of stay in ICU and cost of their care. Additionally, the current financial crisis in Greece find Greek ICUs with even less recourses in terms of supplies, equipment and inevitably with very low nurse-to-patient staffing ratios and insufficient numbers of experienced nurses and trained health care workers. Furthermore, there are no known published studies which they have specifically studied the reduction of CLABSI rates through the development of a multifaceted approach in Greece.

I kindly request your permission to distribute a questionnaire to all physicians and registered nurses (RGN) of the medical critical care of your hospital. Furthermore, an observation of current practices on CLABSI prevention will be held in the above ICU. Observation will be proceeded the questionnaire survey. The information provided will be treated as **confidential and the questionnaires will be anonymous**. Observation data will also remain **anonymous** and no other identifying data will be collected from them and the results of the study will be at your disposal for information purposes at the second semester in 2015.

Thanking you in advance for your assistance.

Yours sincerely

Katerina Iliopoulou, RN, MSc

(Αθήνα, 24 Οκτωβρίου 2014)

Αγαπητέ/ή Πρόεδρε της Επιστημονικής Επιτροπής,

Ονομάζομαι Κατερίνα Ηλιοπούλου είμαι νοσηλεύτρια Μονάδα Εντατικής Θεραπείας (ΜΕΘ) και εργάζομαι ως Προϊσταμένη στη ΜΕΘ του 401 ΓΣΝΑ. Παράλληλα εκπονώ το ερευνητικό μέρος της διδακτορικής μου διατριβής στη Νοσηλευτική Σχολή του King΄s College, στο Ηνωμένο Βασίλειο.

Το θέμα της διατριβής μου είναι «Πρωτοβουλία βελτίωσης ποιότητας η οποία στοχεύει στη μείωση των λοιμώξεων αιματικής ροής σχετιζόμενων με παρουσία κεντρικού φλεβικού καθετήρα» (πρωτότυπος τίτλος: "*Quality improvement initiative aiming at reducing Central Line Associated Bloodstream Infections (CLABSIs) in a medical intensive care unit*).

Το υπό διερεύνηση θέμα είναι σημαντικό καθώς οι δείκτες των CLABSIs στην Ελλάδα είναι υψηλότεροι σε σχέση με αυτούς που αναφέρονται στην Ευρώπη και τις Ηνωμένες Πολιτείες της Αμερικής. Οι αυξημένοι δείκτες CLABSIs συνδέονται με αυξημένη θνησιμότητα και αύξηση του κόστους θεραπείας. Η παραπάνω μελέτη επιδιώκει να εξετάσει εάν η ανάπτυξη μιας πολυδιάστατης, εξατομικευμένης παρέμβασης που βασίζεται στη θεωρία της *αιτιολογημένης δράσης*, θα μειώσει τη συχνότητα των CLABSIs στη ΜΕΘ. Για το σκοπό αυτό θα διερευνηθούν οι τρέχουσες πρακτικές που αφορούν στα μέτρα πρόληψης των CLABSIs, τα εμπόδια και οι διευκολυντικοί παράγοντες της συμμόρφωσης του ιατρο- νοσηλευτικού προσωπικού με αυτά.Τα αποτελέσματα θα χρησιμοποιηθούν για να σχεδιαστεί μια εξατομικευμένη, πολυδιάστατη παρέμβαση η οποία στοχεύει στη μείωση των CLABSIs και θα εφαρμοστεί σε Μονάδα Εντατικής Θεραπείας ενός δημοσίου Νοσοκομείου στο Λεκανοπέδιο Αττικής.

Η συλλογή δεδομένων θα πραγματοποιηθεί μέσω παρατήρησης και ερωτηματολογίου. Στη ΜΕΘ του Νοσοκομείου σας δεν θα πραγματοποιηθεί παρατήρηση. Θα διανεμηθεί μέρος του συνολικού ερωτηματολογίου προκειμένου να προκύψει ικανός αριθμός συμμετεχόντων για τη διερεύνηση των επιμέρους ερωτημάτων και σχέσεων που αφορούν στη παραπάνω μελέτη. Το ερωτηματολόγιο θα διανεμηθεί στους ιατρούς και νοσηλευτές που εργάζονται στη ΜΕΘ και στοχεύει στην αναγνώριση των πρακτικών τοποθέτησης και φροντίδας των κεντρικών καθετήρων καθώς και των πιθανών εμποδίων που αναστέλλουν την πρόθεση συμμόρφωσης τους με τα μέτρα πρόληψης των CLABSIs που βασίζονται σε ''ενδείξεις'' (evidence-based).

Ως εκ τούτου, παρακαλώ θερμά όπως μου επιτραπεί η διανομή του παραπάνω ερωτηματολογίου. Όλες οι πληροφορίες που θα συλλεχθούν θα παραμείνουν **αυστηρά εμπιστευτικές καθώς τα ερωτηματολόγια θα είναι ανώνυμα.** Η παράδοση συμπληρωμένων ερωτηματολογίων προϋποθέτει συναίνεση συμμετοχής στη μελέτη.

Ευχαριστώ για τη συνεργασία. Με εκτίμηση

Κατερίνα Ηλιοπούλου
Νοσηλεύτρια ΜΕΘ
2107494516-515
Katerina.iliopoulou@kcl.ac.uk

ΥΣ. Επισυνάπτεται η έγκριση της μελέτης από την Επιτροπή Ηθικής του Πανεπιστημίου.

Σημείωση: η συγκεκριμένη έρευνα χρηματοδοτείται από την ερευνήτρια

APPENDIX 15: EXAMPLE OF FIELDWORK CONTENT ANALYSIS FROM CRITICAL CARE PERSONNEL ACCOUNTS DURING BASELINE ASSESSMENT

4-8-2014: informal discussion with nurses	**Initial coding**	**Categorising**
A nurse said (1): The physicians just not appreciate our contribution to patient's care	Nurses feel that are not valued by physicians	Low morale: lack of respect and recognition
A nurse said (2): I did not do the right things while I am handling the lumens of the CL because there is a kind of chaos with my patients, I am looking after 3 patients	CLABSI preventive measures are not applied by nurses Increased workload for nurses	Lack of infection control and prevention Features of ICU work
A nurse said (3): it is confusing to me. Physicians don't' want us to take decisions but during late shifts we do everything when they go to rest	Physicians do not want nurses to take decisions	Low morale: lack of respect and recognition Features of ICU work
24-9-2014: informal discussion with physicians		
A physician (1) said I think that nurses do not care. It only matters to them to finish their shift. A CLABSI prevention was organised from the ICU and their attendance was too low.	Physicians value low nurses' engagement Demotivation of nurses to develop themselves professionally	Low morale: lack of respect and recognition
Another physician (2) was asked if he would like nurses to be more autonomous. He replied: It's fine…but nurses have not convinced me that I can trust them to take decisions…somehow, they have disappointed me. They have drawn a red line which places us opposite them.	Nurses are not trusted to take decisions Lack of communication	Communication

APPENDIX 16: Descriptive statistics for items in self-efficacy scale in descending order according to the mean for physicians

Items	Mean (SD)	Median (IQR)
I can manage to perform all infection control measures every time I *insert* a central line in the ICU I work, even if some colleagues may not know about evidence- based guidelines on CLABSIs prevention	5.7 (1.8)	6.5 (5 - 7)
I can manage to perform all infection control measures every time I *insert* a central line in the ICU I work, even if some staff disagree with the evidence-based guidelines on CLABSI prevention.	5.1 (2.2)	6 (4 - 7)
I can manage to perform all infection control measures every time I *insert* a central line, even if nursing staffing is low.	4.8 (2.2)	6 (3 - 7)
I can manage to perform all infection control measures every time I *insert* a central line in the ICU I work, even if the insertion of a central line is an emergency procedure	4.8 (1.9)	5 (3.5 - 6)
I can manage to perform all infection control measures every time I *insert* a central line in the ICU I work, even if support from senior medical managers to apply guidelines on CLABSIs prevention is not strong.	4.7 (2.3)	6 (2.5 - 7)
I can manage to perform all infection control measures every time I *insert* a central line in the ICU I work, even if occasionally standards of care regarding CLABSIs prevention are low	4.7 (2.0)	5 (3 - 6)
I can manage to perform all infection control measures every time I *insert* a central line in the ICU I work, even if sometimes there is low reinforcement from hospital administrators to apply evidence-based measures on CLABSI prevention	4.5 (2.2)	5 (2 - 6)
I can manage to perform all infection control measures every time I *insert* a central line in the ICU I work, even if I don't have sufficient time	4.4 (2.1)	5 (3 - 6)
I can manage to perform all infection control measures every time I *insert* a central line in the ICU I work, even if dissemination of infection control policies is not effective.	4.4 (2.0)	5 (2.5 - 6)
I can manage to perform all infection control measures every time I *insert* a central line in the ICU I work, even if in service education regarding CLABSIs prevention is not adequate.	4.2 (2.0)	4 (3 - 6)
I can manage to perform all infection control measures every time I *insert* a central line, even if there is lack of supplies in the ICU, I work	2.8 (2.0)	2 (1 - 4)

SD: standard deviation, IQR: interquartile range

Descriptive statistics for items in self-efficacy scale in descending order according to the mean for nurses

Items	Mean (SD)	Median (IQR)
I can manage to perform all infection control measures every time I *handle or care* a central line in the ICU I work, even if some colleagues may not know about evidence- based guidelines on CLABSIs prevention	5.6 (1.8)	6 (4 - 7)
I can manage to perform all infection control measures every time I *handle or care* a central line in the ICU I work, even if some staff disagree with the evidence-based guidelines on CLABSI prevention.	5.5 (1.7)	6 (5 - 7)
I can manage to perform all infection control measures every time I *handle or care* a central line in the ICU I work, even if support from senior nurse managers to apply guidelines on CLABSIs prevention is not strong.	5.3 (1.7)	6 (4 - 6.5)
I can manage to perform all infection control measures every time I *handle or care* a central line in the ICU I work, even if sometimes there is low reinforcement from hospital administrators to apply evidence- based measures on CLABSI prevention	5.2 (1.7)	6 (4 - 7)
I can manage to perform all infection control measures every time I *handle or care* a central line in the ICU I work, even if in service education regarding CLABSIs prevention is not adequate.	5.1 (1.6)	6 (4 - 6)
I can manage to perform all infection control measures every time I *handle or care* a central line in the ICU I work, even if the insertion of a central line is an emergency procedure	4.8 (1.7)	5 (3 - 6)
I can manage to perform all infection control measures every time I *handle or care* a central line in the ICU I work, even if dissemination of infection control policies is not effective.	4.8 (1.6)	5 (4 - 6)
I can manage to perform all infection control measures every time I *handle or care* a central line, even if nursing staffing is low.	4.7 (1.8)	5 (3 - 6)
I can manage to perform all infection control measures every time I *handle or care* a central line in the ICU I work, even if occasionally standards of care regarding CLABSIs prevention are low	4.6 (1.7)	5 (3 - 6)
I can manage to perform all infection control measures every time I *handle or care* a central line in the ICU I work, even if I don't have sufficient time	4.5 (1.7)	5 (3 - 6)
I can manage to perform all infection control measures every time I *handle or care* a central line, even if there is lack of supplies in the ICU, I work	3.0 (1.6)	3 (2 - 4)

SD: standard deviation, IQR: interquartile range

APPENDIX 17: Descriptive statistics for items in behavioural intention scale in descending order according to the mean for physicians

Items	Mean (SD)	Median (IQR)
How often do you wear sterile gloves during insertion of a central line?	6.9 (0.8)	7 (7 - 7)
How often do you wash or disinfect your hands before insertion?	6.8 (0.7)	7 (7 - 7)
How often do you wear gown during insertion of a central line?	6.6 (1.3)	7 (7 - 7)
How often do you cover the insertion site with sterile transparent, semi-permeable dressings?	6.6 (1.1)	7 (7 - 7)
How often do you use sterile full body drape during insertion of a central line?	6.5 (1.3)	7 (7 - 7)
How often do you use mask during insertion of a central line?	6.4 (1.6)	7 (7 - 7)
How often do you wear cap during insertion of a central line?	6.3 (1.6)	7 (6.5 - 7)
How often do you use chlorhexidine with alcohol >0.5%, for skin antisepsis during insertion of a central line?	5.3 (2.1)	7 (4 - 7)
How often do you select subclavian site to insert a central line?	4.7 (1.5)	5 (4 - 6)
How often do you select femoral site to insert a central line?	3.1 (1.3)	3 (2 - 4)

SD: standard deviation, IQR: interquartile range

Descriptive statistics for items in behavioural intention scale in descending order according to the mean for nurses

Items	Mean (SD)	Median (IQR)
How often do you replace dressings that are wet, soiled, or dislodged?	6.7 (0.7)	7 (7 - 7)
How often do you access catheters only with sterile devices?	6.5 (0.9)	7 (6 - 7)
How often do you perform dressing changes under aseptic technique using clean or sterile gloves?	6.4 (1)	7 (6 - 7)
How often do you wash or disinfect your hands before handling a central line?	6.1 (1.1)	7 (6 - 7)
How often do you scrub the access port or hub immediately prior to each use with an appropriate antiseptic?	5.8 (1.6)	6 (5 - 7)

SD: standard deviation, IQR: interquartile rang

APPENDIX 18: Descriptive statistics for items in attitudinal scale in descending order according to the mean for physicians

I Items	Mean (SD)	Median (IQR)
Overall, I think that implementing evidence-based measures during insertion of a central line in order to prevent CLABSIs is: Unnecessary practice Necessary practice	6.4 (1.7)	7 (7 - 7)
Overall, I think that implementing evidence-based measures during insertion of a central line in order to prevent CLABSIs is: Easy practice Difficult practice	2.6 (1.7)	2 (1 - 4)
Overall, I think that implementing evidence-based measures during insertion of a central line in order to prevent CLABSIs is: Important practice Not important practice	1.9 (1.9)	1 (1 - 1)
Overall, I think that implementing evidence-based measures during insertion of a central line in order to prevent CLABSIs is: Good practice Bad practice	1.8 (1.9)	1 (1 - 1)

SD: standard deviation, IQR: interquartile range

Descriptive statistics for items in attitudinal scale in descending order according to the mean for nurses

Items	Mean (SD)	Median (IQR)
Overall, I think that implementing evidence-based measures during handling or care of a central line in order to prevent CLABSIs is: Unnecessary practice Necessary practice	6.6 (1.0)	7 (6.5 - 7)
Overall, I think that implementing evidence-based measures during handling or care of a central line in order to prevent CLABSIs is: Easy practice Difficult practice	2.4 (1.6)	2 (1 - 4)
Overall, I think that implementing evidence-based measures during handling or care of a central line in order to prevent CLABSIs is: Good practice Bad practice	1.7 (1.4)	1 (1 - 2)
Overall, I think that implementing evidence-based measures during handling or care of a central line in order to prevent CLABSIs is: Important practice Not important practice	1.6 (1.5)	1 (1 - 1)

SD: standard deviation, IQR: interquartile range

APPENDIX 19: Descriptive statistics for items in behavioural belief scale in descending order according to the mean for physicians

Items	Mean (SD)	Median (IQR)
Avoidance of colonization of a central line as a result of implementing evidence-based infection control measures during insertion of a central line is desirable	6.9 (0.5)	7 (7 - 7)
Reducing CLABSIs rates as a result of implementing evidence-based infection control measures during insertion of a central line is desirable	6.9 (0.3)	7 (7 - 7)
For me, not being able to implement the evidence-based infection control measures during insertion of a central line as a result of nursing shortage is not desirable	6.8 (0.8)	7 (7 - 7)
Reducing patients' length of stay in ICU as a result of implementing evidence-based infection control measures during insertion of a central line is desirable	6.8 (0.6)	7 (7 - 7)
Standardization of practice as a result of implementing evidence-based infection control measures during insertion of a central line is desirable.	6.8 (0.5)	7 (7 - 7)
Implementing evidence-based measures during insertion of a central line will promote standardization of catheter's insertion practice	6.7 (1.0)	7 (7 - 7)
Implementing evidence-based infection control measures during insertion of a central line will reduce CLABSI rates	6.7 (0.6)	7 (7 - 7)
Implementing evidence-based infection control measures during insertion of a central line will reduce expenses	6.6 (1.2)	7 (7 - 7)
Reducing expenses as a result of implementing evidence-based infection control measures during insertion of a central line is desirable	6.3 (1.3)	7 (6 - 7)
Implementing evidence-based measures during insertion of a central line will reduce patient's LOS in ICU	6.1 (0.9)	6 (5 - 7)
Reducing wastage of supplies as a result of implementing evidence-based infection control measures during insertion of a central line is desirable	6.0 (1.7)	7 (6 - 7)
Implementing evidence-based infection control measures during insertion of a central line, will avoid colonization of the catheter.	6.0 (1.5)	6.5 (6 - 7)
Implementing evidence-based measures towards CLABSIs prevention will reduce the wastage of supplies	6.0 (1.2)	6 (5.5 - 7)
Lack of appropriate number of nurses will restrain me to implement evidence-based measures towards CLABSIs prevention	4.6 (2.2)	5 (2.5 - 6.5)
Increase in time required as a result of implementing evidence-based infection control measures during insertion of a central line is not- desirable	3.7 (2.3)	4 (1 - 6)
Implementing evidence-based measures during insertion of a central line, it is time consuming	3.5 (2.1)	3.5 (2 - 5)

SD: standard deviation, IQR: interquartile range

Descriptive statistics for items in behavioural belief scale in descending order according to the mean for nurses

Items	Mean (SD)	Median (IQR)
Reducing patients' length of stay in ICU as a result of implementing evidence-based measures during handling or care of a central line is desirable	6.6 (0.7)	7 (6 - 7)
Avoidance of colonization of a central line as a result of implementing evidence-based measures during handling or care of a central line is desirable	6.5 (0.9)	7 (6 - 7)
Reducing CLABSIs rates as a result of implementing evidence-based measures during handling or care of a central line is desirable	6.5 (0.9)	7 (6 - 7)
Implementing evidence-based measures during handling or care of a central line will reduce CLABSI rates	6.5 (0.8)	7 (6 - 7)
For me, not being able to implement the evidence-based measures during handling or care of a central line as a result of nursing shortage is not desirable	6.3 (1.3)	7 (6 - 7)
Implementing evidence-based measures during handling or care of a central line, will avoid colonization of the catheter	6.3 (1.0)	7 (6 - 7)
Standardization of practice as a result of implementing evidence-based measures during handling or care of a central line is desirable.	6.3 (1.0)	7 (6 - 7)
Implementing evidence-based measures during handling or care of a central line will reduce expenses	6.2 (1.4)	7 (6 - 7)
Implementing evidence-based measures during handling or care of a central line will promote standardization of catheter's handling or care practice	6.2 (1.0)	6.5 (6 - 7)
Reducing expenses as a result of implementing evidence-based measures during handling or care of a central line is desirable	6.1 (1.4)	7 (6 - 7)
Reducing wastage of supplies as a result of implementing evidence-based measures during handling or care of a central line is desirable	6.0 (1.5)	7 (6 - 7)
Implementing evidence-based measures during handling or care of a central line will reduce patient's LOS in ICU	5.7 (1.4)	6 (5 - 7)
Implementing evidence-based measures during handling or care of a central line will reduce the wastage of supplies	5.1 (1.7)	5 (4 - 7)
Increase in time required as a result of implementing evidence-based measures during handling or care of a central line is not- desirable	4.2 (1.9)	4.5 (3 - 6)
Lack of appropriate number of nurses will restrain me to implement evidence-based measures during handling or care of a central line	3.8 (2.0)	4 (2 - 5.5)
Implementing evidence-based measures during handling or care of a central line, it is time consuming	3.4 (1.8)	3 (2 - 5)

SD: standard deviation, IQR: interquartile range

APPENDIX 20: Descriptive statistics for items in the subjective norm scale in descending order according to the mean for physicians

Items	Mean (SD)	Median (IQR)
It is expected of me that I implement evidence-based infection control measures during insertion of a central line	6.8 (0.6)	7 (7 - 7)
Colleagues whose opinions I value would approve of my implementing the evidence-based infection control measures during insertion of a central line	5.8 (1.9)	7 (5 - 7)
Colleagues whose opinion I value think that I should NOT implement evidence-based infection control measures during insertion of a central line	1.8 (1.6)	1 (1 - 1.5)

SD: standard deviation, IQR: interquartile range

Descriptive statistics for items in the subjective norm scale in descending order according to the mean for nurses

Items	Mean (SD)	Median (IQR)
It is expected of me that I implement evidence-based infection control measures during handling or care of a central line	6.6 (0.9)	7 (7 - 7)
Colleagues whose opinions I value would approve of my implementing the evidence-based infection control measures during handling or care of a central line	4.2 (2.1)	4 (2 - 6)
Colleagues whose opinion I value think that I should NOT implement evidence-based infection control measures during handling or care of a central line	1.9 (1.4)	1 (1 - 2)

SD: standard deviation, IQR: interquartile range

APPENDIX 21: Descriptive statistics for items in the normative belief scale in descending order according to the mean for physicians

Items	Mean (SD)	Median (IQR)
Other physicians who work in a critical care setting implement evidence-based infection control measures when they insert a central line	6.2 (1.1)	7 (6 - 7)
The approval of my medical director is important to me	5.4 (1.7)	6 (4 - 7)
My physician colleagues think that I should not implement evidence-based infection control measures during insertion of a central line	5.2 (2.2)	6 (4 - 7)
Generally speaking, I care what my physician colleagues think that I should do	3.9 (2.3)	4 (1 - 6)
My medical director would approve of my implementing evidence-based infection control measures during insertion of a central line.	1.8 (1.8)	1 (1 - 1)

SD: standard deviation, IQR: interquartile range

Descriptive statistics for items in the normative belief scale in descending order according to the mean for nurses

Items	Mean (SD)	Median (IQR)
The approval of my nurse director is important to me	5.4 (1.8)	6 (4 - 7)
Other critical care nurses implement evidence-based infection control measures when they handle or care a central line	5.1 (1.5)	5 (4 - 6)
My nurse colleagues think that I should not implement evidence-based infection control measures during handling or care of a central line	4.5 (2.2)	5 (2.5 - 7)
Generally speaking, I care what my nurse colleagues think that I should do	3.3 (2.2)	3 (1 - 5)
My nurse director would approve of my implementing evidence-based infection control measures during handling or care of a central line.	1.9 (1.5)	1 (1 - 2)

SD: standard deviation, IQR: interquartile range

APPENDIX 22: Descriptive statistics for items in the Context Assessment Index sub-scales

Descriptive statistics for items in the *culture* sub-scale in descending order according to the mean for physicians

Items	Mean (SD)
Patients are encouraged to participate in feedback on quality of care, culture, and systems	2.59 (0.71)
Patients have choice in assessing, planning, and evaluating their care and treatment	2.53 (0.72)
Resources are available to provide evidence-based care	2.35 (0.79)
A staff performance review process is in place that enables reflection on practice and goal setting and is regularly reviewed	2.29 (0.69)
Appropriate information (large written print, tapes, etc.) is accessible to patients	2.24 (0.75)
Staff receive feedback on the outcomes of complaints	2.12 (0.78)
Staff use reflective processes (e.g., action learning, clinical supervision, or reflective diaries) to evaluate and develop practice	2.06 (0.9)
A proactive approach to care is taken	2.06 (0.75)
HCPs [a] and health care support workers understand each other's role	1.88 (0.6)
Challenges to practice are supported and encouraged by nurse leaders and nurse managers	1.76 (0.83)
The development of staff expertise is viewed as a priority by nurse leaders	1.76 (0.75)
There is high regard for patient's privacy and dignity	1.71 (0.85)
Personal and professional boundaries between HCPs [a] are maintained	1.71 (0.69)
HCPs share common goals and objectives about patient care	1.65 (0.7)
Clinical nurse leaders create an environment conducive to the development and sharing of ideas	1.35 (0.49)
Education of staff is a priority	1.29 (0.47)

SD: standard deviation

Descriptive statistics for items in the *culture* sub-scale in descending order according to the mean for nurses

Items	**Mean (SD)**
Patients have choice in assessing, planning, and evaluating their care and treatment	3.2 (0.62)
Patients are encouraged to participate in feedback on quality of care, culture, and systems	3.05 (0.6)
Staff receive feedback on the outcomes of complaints	2.9 (0.85)
HCPs [a] and health care support workers understand each other's role	2.85 (0.93)
A staff performance review process is in place that enables reflection on practice and goal setting and is regularly reviewed	2.85 (0.59)
Staff use reflective processes (e.g., action learning, clinical supervision, or reflective diaries) to evaluate and develop practice	2.8 (0.62)
Appropriate information (large written print, tapes, etc.) is accessible to patients	2.7 (0.92)
The development of staff expertise is viewed as a priority by nurse leaders	2.6 (0.94)
Personal and professional boundaries between HCPs are maintained	2.55 (0.76)
Resources are available to provide evidence-based care	2.5 (0.61)
Education of staff is a priority	2.35 (1.14)
A proactive approach to care is taken	2.35 (0.81)
HCPs [a] share common goals and objectives about patient care	2.25 (0.85)
Challenges to practice are supported and encouraged by nurse leaders and nurse managers	2.1 (0.85)
There is high regard for patient's privacy and dignity	2.05 (0.83)
Clinical nurse leaders create an environment conducive to the development and sharing of ideas	1.7 (0.73)

SD: standard deviation

Descriptive statistics for items in the *leadership* sub-scale in descending order according to the mean for physicians

Items	Mean (SD)
HCPs[a] provide opportunities for patients to participate in decisions about their own care	2.47 (0.87)
Decisions on care and management are clearly documented by all staff	2.12 (0.86)
Discussions are planned between HCPs and patients	2.06 (0.75)
HCPs have the opportunity to consult with specialists	1.94 (0.66)
HCPs in the MDT[b] have equal authority (respect of expertise work) in decision making	1.88 (0.78)
Evidence-based knowledge on care is available to staff	1.71 (0.59)
The management structure is democratic and inclusive	1.47 (0.51)

[a] Health care practitioners [b] Multidisciplinary team SD: standard deviation

Descriptive statistics for items in the *leadership* sub-scale in descending order according to the mean for nurses

Items	Mean (SD)
HCPs[a] in the MDT[b] have equal authority (respect of expertise work) in decision making	3.35 (0.49)
Discussions are planned between HCPs and patients	3.2 (0.62)
HCPs[a] provide opportunities for patients to participate in decisions about their own care	3.0 (0.86)
Decisions on care and management are clearly documented by all staff	2.6 (0.88)
The management structure is democratic and inclusive	2.55 (0.83)
Evidence-based knowledge on care is available to staff	2.5 (0.61)
HCPs have the opportunity to consult with specialists	2.25 (0.64)

[a] Health care practitioners [b] Multidisciplinary team SD: standard deviation

Descriptive statistics for items in the *evaluation of practices* sub-scale in descending order according to the mean for physicians

Items	Mean (SD)
Organizational management has high regard for staff autonomy (working independently)	2.71 (0.77)
The organization is non-hierarchical-(consensus)	2.71 (0.69)
Patients are encouraged to be active participants in their own care	2.59 (0.87)
Structured programs of education are available to all HCPs	2.06 (0.66)
Staff have explicit understanding of their own attitudes and beliefs toward the provision of care	2.0 (0.79)
HCPs and patients work as partners, providing individual patient care	1.94 (0.9)
Staff welcome and accept cultural diversity	1.88 (0.6)
HCPs feel empowered to develop practice	1.76 (0.66)
Audit and/or research findings are used to develop practice	1.76 (0.56)
All aspects of care/treatment are based on evidence of best practice	1.65 (0.79)
There are good working relations between clinical and non-clinical staff	1.65 (0.49)
Guidelines and protocols based on evidence of best practice (patient experience, clinical experience, and research) are available	1.59 (0.62)
The nurse leader acts as a role model of good practice	1.53 (0.51)
Care is based on a comprehensive assessment	1.41 (0.62)

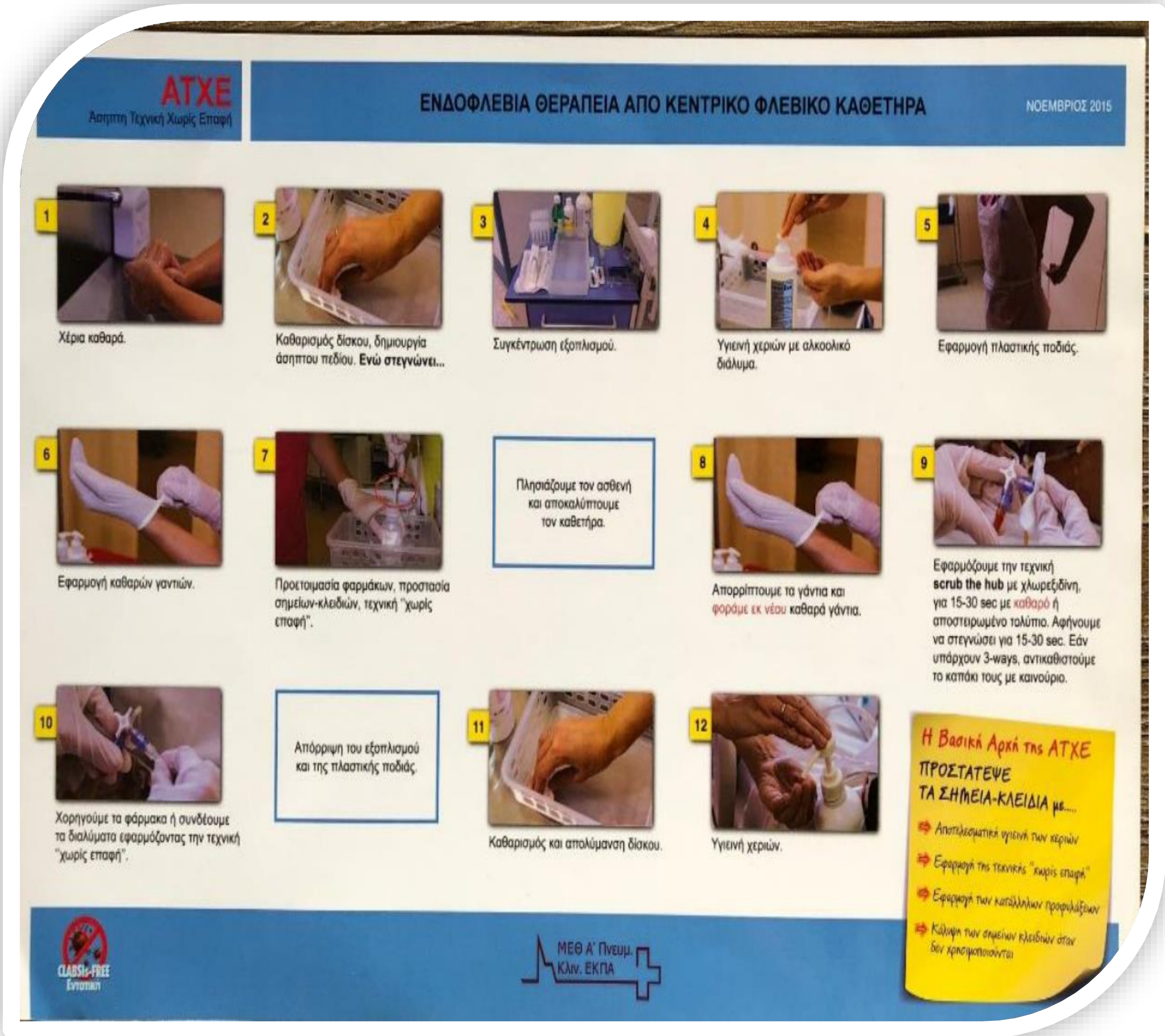
SD: standard deviation

Descriptive statistics for items in the *evaluation of practices* sub-scale in descending order according to the mean for nurses

Items	Mean (SD)
Organizational management has high regard for staff autonomy (working independently)	3.25 (0.64)
Patients are encouraged to be active participants in their own care	3.1 (0.55)
Structured programs of education are available to all HCPs	2.7 (0.8)
The organization is non-hierarchical-(consensus)	2.55 (0.76)
Staff have explicit understanding of their own attitudes and beliefs toward the provision of care	2.5 (0.76)
There are good working relations between clinical and non-clinical staff	2.25 (0.72)
All aspects of care/treatment are based on evidence of best practice	2.25 (0.55)
Audit and/or research findings are used to develop practice	2.25 (0.44)
HCPs feel empowered to develop practice	2.2 (0.83)
Staff welcome and accept cultural diversity	2.15 (0.81)
HCPs and patients work as partners, providing individual patient care	2.15 (0.49)
Guidelines and protocols based on evidence of best practice (patient experience, clinical experience, and research) are available	2.1 (0.72)
Care is based on a comprehensive assessment	2.1 (0.55)
The nurse leader acts as a role model of good practice	1.65 (0.93)

SD: standard deviation

APPENDIX 23: IMAGES THAT DEMONSTRATING THE ASEPTIC-NON-TOUCH-TECHNIQUE



APPENDIX 24: **Descriptive statistics for items in the Context Assessment Index sub-scales for physicians and nurses between the baseline and intervention period**

Descriptive statistics for items in the *culture* sub-scale in descending order according to the mean for physicians between the baseline and the intervention period

Items	Baseline period (n=17)		(n=11)	
	Mean (SD)	Median (IQR)	Mean (SD)	Median (IQR)
Personal and professional boundaries between HCPsa are maintained	3.3 (0.7)	3 (3-4)	3.5 (0.5)	3 (3-4)
A proactive approach to care is taken	2.9 (0.7)	3 (3-3)	3.1 (0.5)	3 (3-3)
Education of staff is a priority	3.7 (0.5)	3 (4-4)	3.6 (0.5)	3 (4-4)
Staff receive feedback on the outcomes of complaints	2.9 (0.8)	3 (2-3.5)	2.9 (0.8)	3 (3-3)
A staff performance review process is in place that enables reflection on practice and goal setting and is regularly reviewed	2.7 (0.7)	3 (2-3)	3.0 (0.7)	3 (3-4)
There is high regard for patients privacy and dignity	3.3 (0.8)	4 (2.5-4)	3.1 (0.8)	4 (2-4)
HCPs and health care support workers understand each other's role	3.1 (0.6)	3 (3-3.5)	3.1 (0.5)	3 (3-3)
Appropriate information (large written print, tapes, etc.) is accessible to patients	2.8 (0.8)	3 (2-3)	2.6 (0.8)	3 (2-3)
Challenges to practice are supported and encouraged by nurse leaders and nurse managers	3.2 (0.8)	3 (3-4)	3.4 (0.5)	3 (3-4)
The development of staff expertise is viewed as a priority by nurse leaders	3.2 (0.8)	3 (3-4)	3.2 (0.9)	3 (2-4)
Staff use reflective processes (e.g., action learning, clinical supervision, or reflective diaries) to evaluate and develop practice	2.9 (0.9)	3 (2-4)	2.8 (0.8)	3 (2-3)
Patients have choice in assessing, planning, and evaluating their care and treatment	2.5 (0.7)	3 (3-3)	2.3 (0.7)	2 (2-3)
Clinical nurse leaders create an environment conducive to the development and sharing of ideas	3.7 (0.5)	4 (3-4)	3.6 (0.5)	4 (3-4)
Patients are encouraged to participate in feedback on quality of care, culture, and systems	2.4 (0.7)	2 (2-3)	2.1 (0.5)	2 (2-2)
Resources are available to provide evidence-based care	2.6 (0.8)	2 (2-3)	2.3 (0.5)	2 (2-3)
HCPs share common goals and objectives about patient care	3.4 (0.7)	3 (3-4)	3.4 (0.5)	3 (3-4)

SD: standard deviation, IQR: interquartile range

Descriptive statistics for items in the *culture* sub-scale in descending order according to the mean for nurses between the baseline and the intervention period

Items	Baseline period (n=20)		(n=11)	
	Mean (SD)	Median (IQR)	Mean (SD)	Median (IQR)
Personal and professional boundaries between HCPsa are maintained	2.5 (0.6)	2.5 (2-3)	3.0 (0.6)	3 (3-3)
A proactive approach to care is taken	2.7 (0.8)	3 (2-3)	3.2 (0.6)	3 (3-4)
Education of staff is a priority	2.7 (1.1)	3 (2-4)	3.3 (0.8)	3 (3-4)
Staff receive feedback on the outcomes of complaints	2.1 (0.9)	2 (1.3-3)	2.7 (1.0)	3 (2-4)
A staff performance review process is in place that enables reflection on practice and goal setting and is regularly reviewed	2.2 (0.6)	2 (2-2.8)	3.1 (1.0)	3 (2-4)
There is high regard for patients privacy and dignity	3.0 (0.8)	4 (3-3)	3.4 (0.9)	4 (3-4)
HCPs and health care support workers understand each other's role	2.2 (0.9)	2 (1-3)	3.1 (0.5)	3 (3-3)
Appropriate information (large written print, tapes, etc.) is accessible to patients	2.3 (0.9)	2 (2-3)	2.3 (0.9)	2 (2-3)
Challenges to practice are supported and encouraged by nurse leaders and nurse managers	2.9 (0.8)	3 (2-3.8)	3.5 (0.5)	4 (3-4)
The development of staff expertise is viewed as a priority by nurse leaders	2.4 (0.9)	2.5 (2-3)	3.3 (0.6)	3 (3-4)
Staff use reflective processes (e.g., action learning, clinical supervision, or reflective diaries) to evaluate and develop practice	2.2 (0.6)	2 (2-3)	2.9 (0.9)	3 (2-4)
Patients have choice in assessing, planning, and evaluating their care and treatment	1.8 (0.6)	2 (1-2)	2.3 (0.9)	2 (2-3)
Clinical nurse leaders create an environment conducive to the development and sharing of ideas	3.3 (0.7)	3 (3-4)	3.7 (0.5)	4 (3-4)
Patients are encouraged to participate in feedback on quality of care, culture, and systems	2.0 (0.6)	2 (2-2)	2.2 (0.8)	2 (2-3)
Resources are available to provide evidence-based care	2.5 (0.6)	3 (2-3)	2.5 (0.7)	2 (2-3)
HCPs share common goals and objectives about patient care	2.8 (0.9)	3 (2-3)	3.5 (0.5)	3 (3-4)

SD: standard deviation, IQR: interquartile range

Descriptive statistics for items in the *leadership* sub-scale in descending order according to the mean for physicians between the baseline and the intervention period

Items	Baseline period (n=17)		(n=11)	
	Mean (SD)	Median (IQR)	Mean (SD)	Median (IQR)
Decisions on care and management are clearly documented by all staff	2.9 (0.9)	3 (2-3.5)	2.9 (0.8)	3 (3-3)
HCPs provide opportunities for patients to participate in decisions about their own care	2.5 (0.9)	3 (2-3)	1.9 (0.7)	2 (1-2)
HCPs in the MDT have equal authority (respect of expertise work) in decision making	3.1 (0.8)	3 (2.5-3)	2.9 (0.7)	3 (2-3)
The management structure is democratic and inclusive	3.5 (0.5)	4 (3-4)	3.3 (0.6)	3 (3-4)
Discussions are planned between HCPs and patients	2.9 (0.8)	3 (3-3)	2.3 (0.6)	2 (2-3)
Evidence-based knowledge on care is available to staff	3.3 (0.6)	3 (3-4)	3.5 (0.5)	3 (3-4)
HCPs have the opportunity to consult with specialists	3.1 (0.7)	3 (3-3.5)	3.1 (0.5)	3 (3-3)

SD: standard deviation, IQR: interquartile range

Descriptive statistics for items in the *leadership* sub-scale in descending order according to the mean for nurses between the baseline and the intervention period

Items	Baseline period (n=20)		(n=11)	
	Mean (SD)	Median (IQR)	Mean (SD)	Median (IQR)
Decisions on care and management are clearly documented by all staff	2.4 (0.9)	2 (2-3)	3.0 (1.0)	3 (2-4)
HCPs provide opportunities for patients to participate in decisions about their own care	2.0 (0.9)	2 (1-3)	2.0 (0.8)	2 (2-2)
HCPs in the MDT have equal authority (respect of expertise work) in decision making	1.7 (0.5)	2 (1-2)	2.5 (0.8)	2 (2-3)
The management structure is democratic and inclusive	2.5 (0.8)	2 (2-3)	3.3 (0.6)	3 (3-4)
Discussions are planned between HCPs and patients	1.6 (0.6)	2 (1-2)	2.3 (0.8)	2 (2-3)
Evidence-based knowledge on care is available to staff	2.5 (0.6)	3 (2-3)	3.2 (0.8)	3 (3-4)
HCPs have the opportunity to consult with specialists	2.8 (0.6)	3 (2-3)	3.2 (0.8)	3 (3-4)

SD: standard deviation, IQR: interquartile range

Descriptive statistics for items in the *evaluation of practices* sub-scale in descending order according to the mean for physicians between the baseline and the intervention period

Items	Baseline period (n=17)		(n=11)	
	Mean (SD)	Median (IQR)	Mean (SD)	Median (IQR)
All aspects of care/treatment are based on evidence of best practice	3.4 (0.8)	4 (3-3)	3.4 (0.7)	3 (3-4)
The nurse leader acts as a role model of good practice	3.5 (0.5)	3 (3-4)	3.5 (0.5)	4 (3-4)
There are good working relations between clinical and non-clinical staff	3.3 (0.5)	3 (3-4)	3.4 (0.5)	3 (3-4)
Audit and/or research findings are used to develop practice	3.2 (0.6)	3 (3-4)	3.3 (0.9)	3 (3-4)
Staff have explicit understanding of their own attitudes and beliefs toward the provision of care	3.0 (0.8)	3 (2-4)	2.7 (0.6)	3 (2-3)
Patients are encouraged to be active participants in their own care	2.4 (0.9)	3 (2-3)	1.9 (0.5)	2 (2-2)
HCPs and patients work as partners, providing individual patient care	3.1 (0.7)	3 (2.5-4)	2.7 (0.8)	3 (2-3)
Care is based on a comprehensive assessment	3.6 (0.6)	4 (3-4)	3.6 (0.5)	4 (3-4)
Organizational management has high regard for staff autonomy (working independently)	2.3 (0.8)	2 (2-2.5)	2.1 (0.5)	2 (2-2)
Staff welcome and accept cultural diversity	3.1 (0.6)	3 (3-3.5)	3.3 (0.5)	3 (3-4)
HCPs feel empowered to develop practice	3.2 (0.7)	3 (3-4)	3.4 (0.7)	3 (3-4)
Guidelines and protocols based on evidence of best practice (patient experience, clinical experience, and research) are available	3.4 (0.6)	3 (3-4)	3.1 (0.7)	3 (3-4)
The organization is non-hierarchical-(consensus)	2.3 (0.7)	2 (2-3)	2.1 (0.7)	2 (2-3)
Structured programs of education are available to all HCPs	2.9 (0.7)	3 (2.5-3)	3.1 (0.5)	3 (3-3)

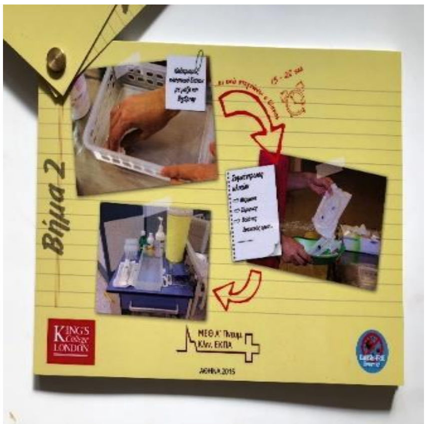
SD: standard deviation, IQR: interquartile range

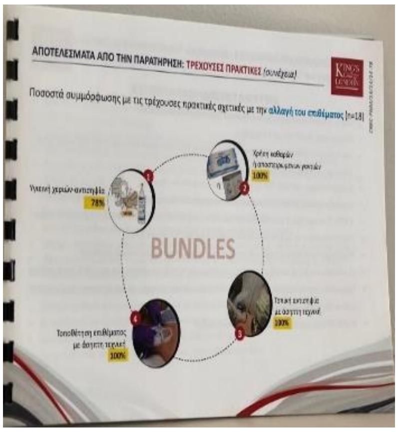
Descriptive statistics for items in the *evaluation of practices* sub-scale in descending order according to the mean for nurses between the baseline and the intervention period

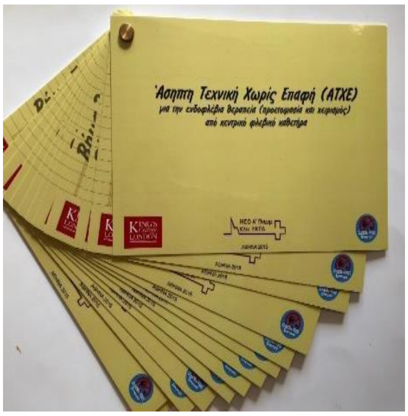
Items	Baseline period (n=20)		(n=11)	
	Mean (SD)	Median (IQR)	Mean (SD)	Median (IQR)
All aspects of care/treatment are based on evidence of best practice	2.8 (0.6)	3 (3-3)	3.3 (0.8)	3 (3-4)
The nurse leader acts as a role model of good practice	3.4 (0.9)	4 (3-4)	3.8 (0.4)	4 (4-4)
There are good working relations between clinical and non-clinical staff	2.8 (0.7)	3 (2-3)	3.0 (0.4)	3 (3-3)
Audit and/or research findings are used to develop practice	2.8 (0.4)	3 (2-3)	3.1 (0.7)	3 (3-4)
Staff have explicit understanding of their own attitudes and beliefs toward the provision of care	2.5 (0.8)	2 (2-3)	3.4 (0.7)	3 (3-4)
Patients are encouraged to be active participants in their own care	1.9 (0.6)	2 (2-2)	2.5 (1.0)	2 (2-3)
HCPs and patients work as partners, providing individual patient care	2.9 (0.5)	3 (3-3)	3.2 (0.6)	3 (3-4)
Care is based on a comprehensive assessment	2.9 (0.5)	3 (3-3)	3.5 (0.5)	3 (3-4)
Organizational management has high regard for staff autonomy (working independently)	1.8 (0.6)	2 (1-2)	2.3 (0.9)	2 (2-3)
Staff welcome and accept cultural diversity	2.9 (0.8)	3 (3-3)	3.3 (0.6)	3 (3-4)
HCPs feel empowered to develop practice	2.8 (0.8)	3 (2-3)	3.3 (0.5)	3 (3-4)
Guidelines and protocols based on evidence of best practice (patient experience, clinical experience, and research) are available	2.9 (0.7)	3 (2-3)	3.3 (0.6)	3 (3-4)
The organization is non-hierarchical-(consensus)	2.5 (0.8)	2 (2-3)	2.6 (0.9)	3 (2-3)
Structured programs of education are available to all HCPs	2.3 (0.8)	2 (2-3)	2.8 (0.8)	3 (2-3)

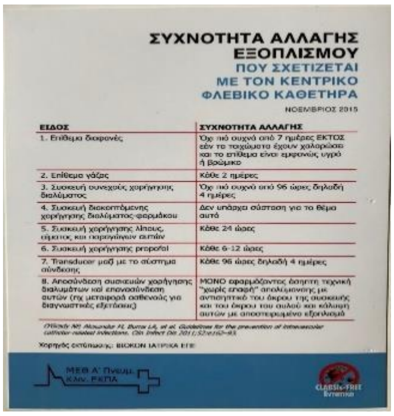
SD: standard deviation, IQR: interquartile range

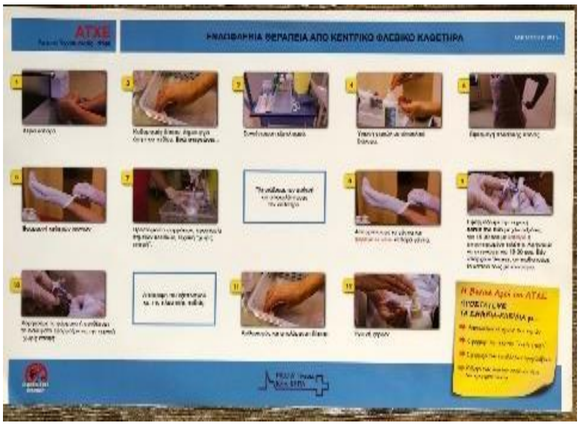
APPENDIX 25: PRINTED MATERIAL THAT AID THE IMPLEMENTATION OF THE INTERVENTION

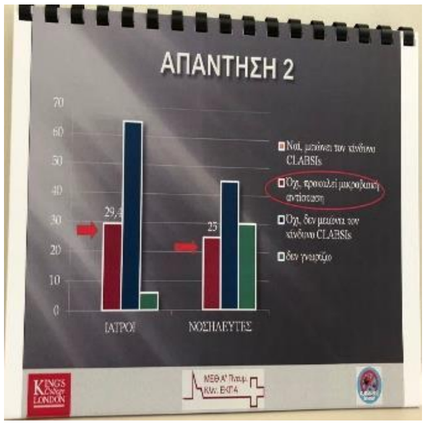












APPENDIX 26: IMAGES DEMONSTRATING THE IMPLEMENTATION OF CORRECT PRACTICES TOWARDS CLABSI PREVENTION WHICH WERE SENT TO STAFF VIA MONTHLY E-MAILS